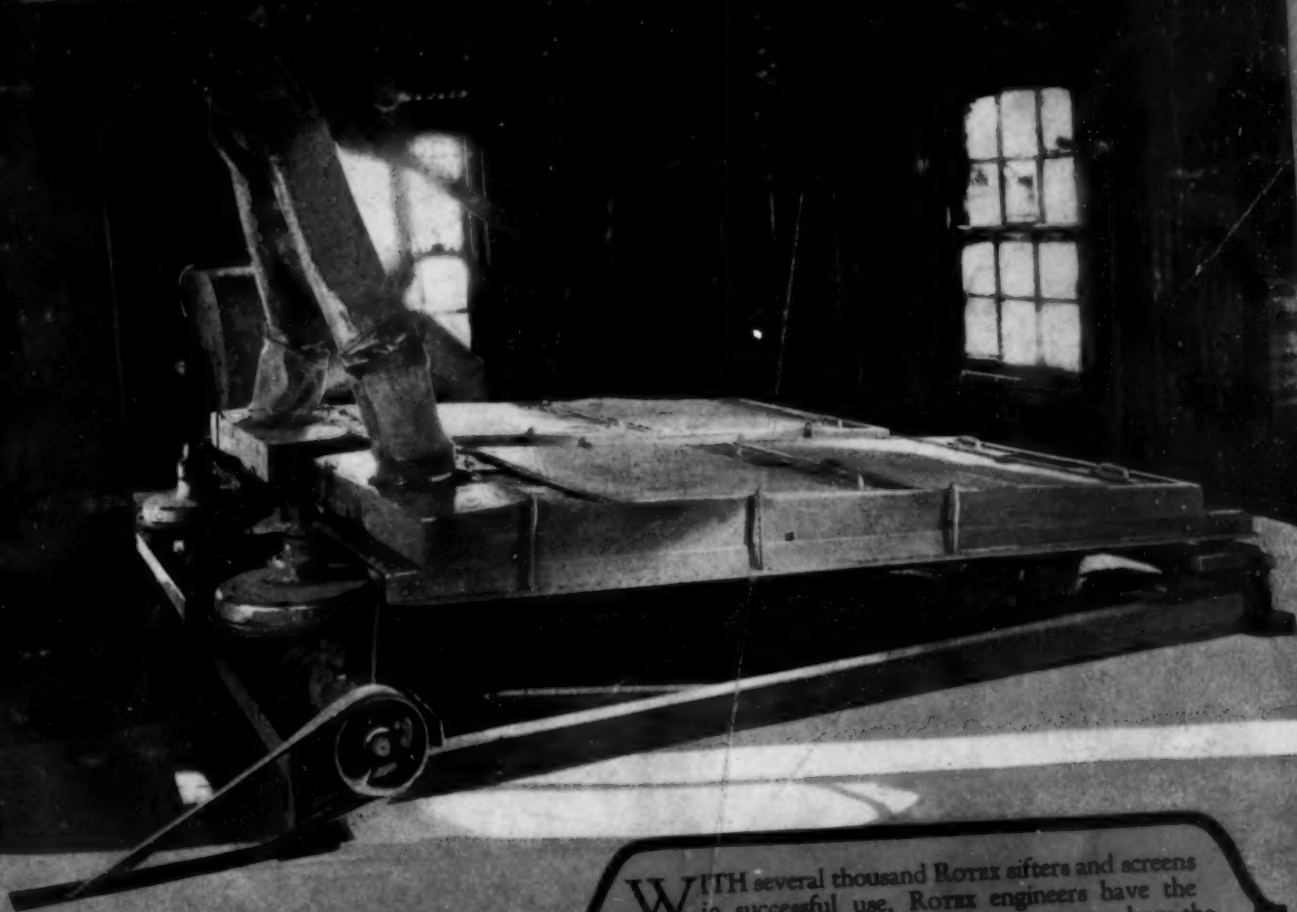


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## *Internationalizing the Chemical Exposition*

**R**ADICALLY changing a policy that has been rigidly enforced for ten years, the advisory committee of the Eleventh Exposition of Chemical Industries has recommended that foreign manufacturers no longer be excluded from exhibiting in the annual show in Grand Central Palace. The recommendation has been adopted, and consequently the exposition next September is likely to include foreign exhibits and take on an international aspect.

**W**HEN the chemical exposition was inaugurated in 1915 its national character was emphasized. The World War was on, and the necessity for stimulating the growth of chemical industry in this country was urgent. There was need of developing a spirit of independent thought and action and of creating a popular appreciation of the relation of chemical industry to the national welfare. The proposal to hold an exposition met with wide and instant approval, and the project was supported by manufacturers of chemicals and equipment, technical societies and the Government.

**I**N the succeeding ten years the exposition grew in size and importance. Successful from the beginning, it was a vital factor in consolidating the position of chemistry in American industry. It made for solidarity and unity of national purpose. As the years passed it offered tangible evidence of achievement that was at once a source of pride and a

stimulus to greater progress and expansion. The enthusiasm of those days is a happy memory.

**W**ITH the end of the War the policy of keeping the exposition strictly national, excepting the friendly co-operation of our Canadian neighbors, was followed to the letter. The exposition was a great success in spite of gradual changes, marked principally by the withdrawal of patronage by chemical manufacturers *per se* and the predominance of equipment makers among the exhibitors. This was a condition as regrettable as it seemed unavoidable, and one that *Chem. & Met.* hopes will yet be changed. An exposition of chemical industries without exhibits of chemical manufacturers is anomalous.

**T**HE decision to internationalize the show is in keeping with the spirit of the times. International relations have long since been resumed between foreign and domestic manufacturers of chemicals and equipment. International travel and commercial intercourse have been conspicuous for the past two or three years. The resulting benefits and advantages, however, have been available to only a few, but it is the expectation that the inclusion of foreign exhibits in the chemical exposition will similarly widen the horizon of a much larger number who cannot travel abroad. The decision should add new interest to the exposition.

### An Important Patent Decision

**I**NVENTORS who seek protection for their intellectual property through the medium of a patent will do well to study the decision of Judge Morris in the suit of the General Electric Co. vs. DeForest Radio Co. for infringement of the former's patent on ductile tungsten and its manufacture. Product and process claims were both involved relating to substantially pure tungsten having ductility and high tensile strength. Both groups of claims were held invalid on the broad ground that ductility is an inherent property of matter; that in the case of tungsten the solution of the difficulties to be overcome before ductile metal could be produced lay in the field of discovery and not in that of invention. In the view of Judge Morris, the research workers of the General Electric Co. did a creditable piece of work in discovering the conditions under which ductility, a natural property of tungsten, could be turned to advantage, but they did not invent an artificial, patentable property of that metal. If the decision carries the significance attributed to it in well informed quarters it warrants the most careful study. It is admirable for its clean cut analysis and logic and takes rank with other decisions on technical subjects for which Judge Morris has become notable.

---

### The German Network of Chemical Cartels

**D**URING the present period of active industrial realignment in Germany, American chemical industry is peculiarly fortunate in having a government representative in Berlin who is competent to observe and interpret developments in their real significance. The reports of William T. Daugherty, American trade commissioner, have always set a high standard for accuracy and thoroughness, but his recent review of "German Chemical Developments in 1926" is an exceptionally useful as well as interesting document. The Department of Commerce has acted wisely in publishing it in pamphlet form (Trade Information Bulletin 451) for it is worthy of wide distribution and careful study.

The mergers and international expansion whereby the German dye trust raised its foundation capital to over a billion marks and thus wrested from the steel combine first place among German industrial organizations is an old story to many of our readers. So, too, is the ambitious program for greatly increased production of synthetic nitrogen compounds and the development of concentrated fertilizer materials containing the two other essentials for plant growth, namely, potash and phosphorus. The report also discusses the progress made in the practical application of the Bergius and Fischer schemes of coal processing, and the rapid development in Germany of rayon, lacquer, organic solvents, new motor fuels, light metals and other electrochemical products.

But while these developments have been widely heralded in the technical press of Europe and this country, Mr. Daugherty remarks a less spectacular trend that probably holds a more general significance for our industries. Even before the war, German industry was characterized by the cartel system of horizontal associa-

tions of competing companies. "Most German chemical producers are organized in trusts, syndicates, conventions and other associations," Mr. Daugherty reports, "in order to maintain price uniformity or to sell communally and sometimes to regulate production by allocation." But where there were relatively few of these cartels in the chemical industry in 1914, the number has now increased to form a complicated network tying together the entire industry. The individual German manufacturer may be bound in as many different cartels as the number of products he produces.

In Germany the stabilizing effect of this super organization is very apparent. Costly competition is avoided, production may be definitely scheduled on the basis of established market quotas. Again this close relation between manufacturers insures a steady flow of materials from one industry to another and thus avoids the "feast or famine" condition which often handicaps our own chemical manufacturers. Insurance is also provided against the uncertainties that accompany changing technology.

It is futile, of course, to picture the transplanting of the cartel system into the United States. Many of its economies, however, such as those resulting from group research, exchange of technical information and organized systematic study of production and consumption requirements, are easily attainable through trade associations and similar organizations. And if we are to meet the competition of the German cartels on an equal footing in this country, it is certain that we must take advantage of every opportunity for co-operation within our own ranks.

---

### Making Gas a Better Industrial Servant

**G**AS is often called the "ideal" industrial fuel, and on the score of controllability, cleanliness, efficiency in use, and over-all convenience it often deserves that designation. However, the use of gas by the chemical engineering industries has been much restricted for two reasons. First, the lack of modern and efficient appliances designed especially for gaseous fuel. Second, the greater cost of gas when available only from public utility companies at the customary retail rates.

The American Gas Association has recognized the first of these difficulties as a problem of national importance. It is attacking the problem seriously and is now preparing to spend a research and development fund of \$100,000 per year for a five-year period. This will be welcome news to the industries that recognize the merit of gas and would like to use it as their plant fuel.

In the past industrial users have been deterred by lack of suitable furnaces and appliances. And appliance manufacturers have been deterred from spending the large sums needed for developing industrial equipment by an apparent lack of prospective customers. The A.G.A. industrial gas research project will break up this unfortunate cycle and will afford the needed information and stimulus for new appliance design. The association is to be congratulated upon this step forward in co-operation with its industrial customer groups.

It now is the duty of the prospective gas users in the chemical engineering industries to do their part by accurately defining their needs. One arrangement to



this end has already been made with the American Baking Institute, which has been commissioned by the American Gas Association to find out just what would constitute the ideal conditions for the baking of bread. The gas man well says, "If you will tell us exactly how you would like to bake the loaf we will produce an appliance to do that job accurately and economically." A similar co-operation with those interested in heat treating of iron and steel is being arranged.

Like co-operation should be developed between the gas association and associations in every line of chemical engineering production. There is no chemical engineering industry that does not have its process heating problems. A careful study of the fundamentals of heating in each of these industries may reveal a community of interest between the gas producers and that industry as a gas user. These can well be served by this large research project.

In many instances the first steps toward co-operation can be taken by an individual company that realizes its peculiar needs in process heating. A company can take up the matter with the city gas company of its own locality and through it, if necessary, with the American Gas Association specialists. In many instances it will be found that appliances suited to the task are already available, having been developed elsewhere by other gas companies or by some gas appliance builder. Where a suitable appliance cannot be had at once steps will be taken toward the development of the needed information and the design of appropriate appliances. It therefore remains the fault of the user industry itself, if it fails to gain the latest and the best in gas-burning equipment.

### Fertilizer Industry Cleans Its House

**S**PURRED to action by the proceedings of the Department of Justice against practices that transgressed the anti-trust law, the fertilizer industry convened in Washington last month for a voluntary housecleaning. In the course of its investigations the Government discovered the demoralized state of the industry, and on the expressed intention of its leaders to "develop a plan of co-operation that will be fair both to the consumers and the competing companies," recommended and obtained acceptance of pleas of *nolite contendere*. At the same time the Government gave the industry some wholesome advice in the interest of better business practices.

Accordingly the leaders of the industry drafted a code of trade practices, submitted it to members of the National Fertilizer Association and secured the adherence of two hundred firms engaged in the fertilizer business. The action was timely and the practical application of the code will do much to put the industry on its feet. It will insure sound accounting methods, elimination of waste, avoidance of secret discriminations, rebates and unsound credit terms, adherence to prices and terms, and the exchange of statistical information. The spirit and intent of the code is acceptable to the Government and future interference with the industry will depend on its abuse of the practices to which it is committed.

Congratulations are in order to the Department of Justice for its spirit of co-operation, and to the National Fertilizer Association for its awakening. With better

business practices ahead it should not fail also to take account of technical developments that ultimately must have a profound effect on the industry. These developments are going on outside the industry at the present time, but will surely invade it as economic conditions change. Chemical engineering is doing things that the present fertilizer industry cannot afford to ignore, and means should be set up inside the industry to keep itself posted on technical progress.

---

### Plant Location and the Chemical Engineer

**W**E WOULD scarcely be human if we failed to acknowledge with some little pride as well as gratification the favorable acclaim with which *Chem. & Met.*'s Fourth Annual Review and Statistical Number was received by its readers. That there is a virile interest in the national development of our chemical industries is most apparent. And whether this development is to take the form of a logical expansion based on consuming requirements, a relocation of plants to conform with changing centers of consumption and raw material resources, or a modernization program to replace obsolete plants and equipment, it is certain that the chemical engineer is to play a prominent part in the transformation process.

Within the past fortnight staid business and financial circles in New York have been unusually stirred by the announcement of plans for an impressive development of nitrogen fixation. A plant site of 300 acres has been purchased at Hopewell, Virginia, and it is reported that millions of dollars are to be expended in building an industry to capitalize on the ten years of research and development work carried on by the Atmospheric Nitrogen Corporation of Syracuse, New York, at an estimated cost of \$4,500,000. But the feature of the announcement that received most comment in the popular press was the fact that the Virginia site was selected in preference to Muscle Shoals or some other source of the hydroelectric power which the public, since the early days of the Norwegian industry, has always associated with nitrogen fixation. As a matter of fact the chemical engineer in the nitrogen industry can definitely show that proximity to coal, convenient markets and the advantages of deep water transportation more than outweigh the sometimes mythical attraction of water power as a factor in the location of a direct synthetic ammonia plant.

It is the economic balancing of many factors that in the end determines the final selection of the plant site. Raw material resources and the requirements of the consuming industries, however, are of prime importance in any choice and it is for this reason that *Chem. & Met.*'s regional surveys have laid principal emphasis on these two factors. This series of articles, begun last month, is to continue throughout the year. On pp. 101 to 109 of this issue the reader will find pertinent discussion of the industrial possibilities of the states of Ohio and Minnesota. Other articles are on hand or in preparation so that shortly *Chem. & Met.*'s readers will have the completed picture of the chemical resources of the entire country. The facts thus made available should prove a valuable guide in shaping the future course of the chemical engineering industries.



# Modern Technology in Producing Pig Aluminum

Most modern methods of making electrodes and primary aluminum demonstrated by the Arvida works of the Aluminum Company of Canada

By R. S. McBride

Assistant Editor, *Chem. & Met.*

THE manufacture of primary or pig aluminum requires supplies of cryolite, of pure alumina, of cheap power, of high-grade electrodes, and of specially designed and specially lined furnaces or "pots." The new plant of the Aluminum Company of Canada at Arvida is laid out to provide for the transforming of such power supply, for the manufacture of the electrodes, and for the lining of the pots, all with a view to the movement of these materials along logical lines from raw materials to the ultimate plant use. But the plant design provides as yet no arrangement for the preparation of either cryolite or pure alumina. These two raw materials are now being brought to the plant ready for use, although at a later date it is likely that arrangements will be made for their purification and preparation at the plant.

The first step in planning the Arvida works was to prepare a general plant lay-out; this work was undertaken by the engineers of the company itself. The site was a level piece of farm land near the tracks of the Canadian National Railways, which was at that time the only means of transportation from this part of the valley to the outside world.

As a part of the plant lay-out there was included considerable trackage, both temporary for handling construction materials and permanent for handling the incoming and outgoing materials and the materials passing from one part of the plant to another. This industrial trackage is connected with the Roberval & Saguenay Railway, which is now owned by the company. This railway has been extended to connect the aluminum plant with the Canadian National Railway and with the company wharves at Port Alfred, the water-shipping point 20 miles away. It has also been extended to the site of the prospective power plant at

Chute-a-Caron, but a short distance from Arvida.

The general plant lay-out, which is shown in Fig. 2, indicates only approximately half of the total projected works. But it includes all of the general plant units, such as office building, hospital, machine shop, forge shop, alumina storage, etc. Also it includes the lay-out of all of the electrode plant. The portion of the projected installation which is not shown on the diagram is mainly additional pot rooms and rotary-converter stations, of which it is intended there shall be five groups of eight pot rooms each, each group having a separate rotary-converter station.

As the description of various parts of the plant proceeds it will be evident that the engineers of the company have laid out the plant in such a manner that there will be a minimum of cross hauling and a maximum of direct communication from one stage of the manufacturing operation to the next.

## THEORY OF ALUMINUM MAKING

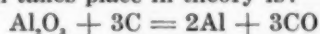
Theoretically the manufacture of aluminum is very simple. It consists of passing direct current through a molten bath of cryolite in which pure alumina is dissolved. To the electrolyte, that is the solution of alumina in molten cryolite, fluorspar or other fluorides may be added in order to reduce the melting point of the mixture below the temperature desired for furnace operation. The current passes from carbon anodes through the electrolyte to the baked carbon lining of the furnace, which serves as the cathode. A section through the furnace, or "pot" as it is called, is shown diagrammatically in Fig. 3.

The metallic aluminum which is deposited on the furnace lining accumulates in a molten condition in the bottom of the furnace, where it is protected from oxida-



Fig. 1—The Aluminum Plant and Industrial Housing at Arvida  
The industrial village is at the left, with site of the new power plants near the falls of the Shipshaw River barely visible in the background (about 2 miles away). The carbon plant is in the central foreground with four furnace rooms beyond and rotary converter station at the rear

tion by the bath of cryolite above it. The oxygen discharged at the anode reacts with the carbon of the electrode to form carbon monoxide and carbon dioxide. The reaction which takes place in theory is:



The resistance of the electrolyte is maintained at a point which generates from the current just sufficient heat to keep the bath molten and at the temperature desired. Some heat is, of course, generated by the oxidation of the anode, but this is a distinctly minor part of the total energy required to maintain the temperature.

Although this theoretical procedure sounds very simple the successful operation of an aluminum furnace commercially involves many complications and great precision in control. As a matter of fact, some of the experimenters who have desired to try out their own ideas regarding improvements in method for manufacture of aluminum have never been able to make any aluminum at all. This may seem absurd to one seeing for the first time the very simple appearance of the procedure which makes a modern aluminum plant a success. But close observation quickly reveals the fact that it is largely the dexterity and experience of the operatives which is making the job seem easy, and the observing visitor is not at all tempted to try for himself to duplicate even the common workman's performance in the control or the tapping of the furnace.

#### HANDLING OF CRYOLITE

As indicated above, the present Arvida plant does not include any arrangement for purification or preparation of the two principal raw materials, alumina and cryolite.

The cryolite, which is mined in Greenland at the only large known source in the world, comes to the plant already ground and purified. The kegs in which it is shipped look very much like an ordinary apple barrel, but it is evident when one tries to move one that the contents is different. As a matter of fact, such a barrel of finely ground and purified cryolite weighs about 550 lb. Needless to say, therefore, mechanical devices are being arranged for unloading of these kegs from the railway cars and for moving them to the desired point in the furnace rooms. Near the furnaces the kegs are opened and dumped into the storage bins and from these the requisite make-up for the electrolyte is added to the bath by the operators, using a small scoop or shovel. In passing it may be observed that a large size

scoop would be quite out of place here, for it is very easy to get much more cryolite in a large scoop than a man can lift or handle easily.

#### SOURCE OF ALUMINA

The secret of making good aluminum is the use of pure raw materials. Almost any metal which goes into the electrolyte will appear in the finished pig. The only exceptions are the alkali and alkaline-earth metals which are electro-negative to aluminum. Any other metals if present in the alumina or other bath constituents show up in the metal tapped from the furnace.

Thus far no arrangement has been made for the manufacture of the pure alumina at Arvida and this raw material is still being brought in from the East St. Louis plant of the Aluminum Company of America in a form ready to add to the furnace. At present the supply is received in bags; but presumably, as the plant grows, some means for handling the finely pulverized precipitated oxide on a larger scale will be developed. It is also probable that the Arvida plant will eventually include equipment for making its own alumina from crude bauxite, but this arrangement has not yet been even tentatively made, because there is still some uncertainty as to which process will prove best adapted to the conditions at this plant. The final arrangement that is made will undoubtedly contemplate handling the bauxite from either American or foreign mines by water in bulk, with transshipment at Port Alfred from vessel to the Roberval & Saguenay Railway car. Thus there will be only the 20-mile rail haul on the bauxite, all of the rest of its travel being by ship, the more economical procedure.

Arvida is one of North America's best illustrations that the world is becoming industrially not only interdependent, but also very small. Here we will eventually have cryolite from Greenland and bauxite from South America coming thousands of miles by water in order that they may be processed with cheap electric power; and the pig aluminum will then move outward on the water for refining, rolling, casting, or other fabrication at plants scattered not only over all of Canada and the United States, but also at far more distant points throughout the world.

#### CONSTRUCTION OF THE POTS

The furnace in which aluminum is made is commonly referred to as a "pot." It is a rectangular box of heavy steel plate made up on angle iron corner framing with



as They Appeared During the Course of Construction in 1926.

The high tension transformer houses appears at the left, with shops under construction and pot-lining building in the center. The large building in the foreground on the right is the coke calcium furnace building. Alumina storage and unloading building under construction are in the extreme left middle.



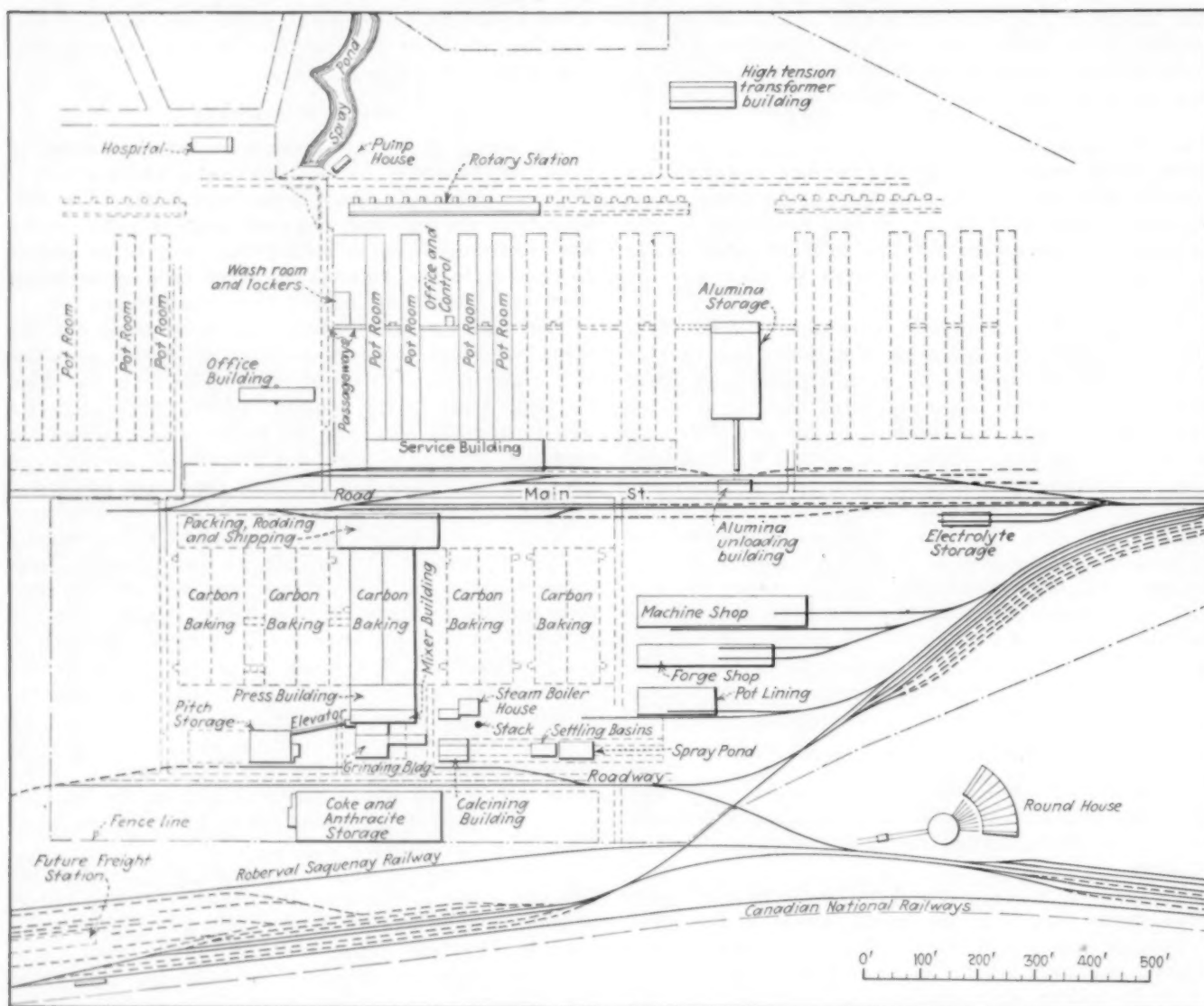


Fig. 2—Layout of the Arvida Plant

In this sketch, present construction is shown with full lines and future connection with broken lines.

a stiffening frame around the top and lugs by which it can be lifted with a crane. An opening for the tap hole is provided at the front of the furnace.

The side plates of the shell are extended at the back to provide electrical connection to the bus-bar system. The other electrical connection is through the anode support, which is a steel frame work supported on the furnace shell but electrically insulated therefrom. Soft steel bars are bolted to the side plates of the furnace shell extending horizontally into the furnace a few inches above the steel bottom, to act as current collectors. The mixture of ground coke with tar and pitch which forms the lining material is rammed into the shell around these collectors in the base and against the side walls. Thus the carbon lining and shell with the attached collector bars are electrically a unit, the cathode of the furnace.

The finished lining of an aluminum pot is virtually a pure baked carbon mass. It, with the steel shell, forms what might appear to be a huge black bath tub, about the size suitable for the ablutions of a young elephant. This lining material is made up of ground coke blended with suitable amounts of tar and pitch, rammed into place, and baked.

The coke used is a high-grade blast furnace or foundry coke, which to be ideal should have a very low

percentage of ash; and this ash should, of course, contain the minimum of those metals which are likely to contaminate the aluminum. On arrival at the plant the coke is dropped into the track hopper from which it is elevated to the coke sizing and drying plant. The first unit of this sizing plant is a spiked-roll crusher which breaks the coke down below the permissible maximum size with the manufacture of a minimum percentage of fines. The coke thus sized is elevated to a storage bin from which it is drawn as required for further treatment. One of the figures shows these and the succeeding units of the coke preparation plant.

The further treatment consists first in grinding in a Sturtevant rotary mill of the sort frequently referred to as the "coffee-mill" type. The discharge from this mill is elevated to a bin which feeds a Ruggles-Coles semi-indirect, coal-fired, rotary drier. The first, or direct-flame, pass of this drier is the central combustion chamber. From it the products discharge into the outer section where they are in direct contact with the coke. A third storage bin receives the output of the drier and serves to feed the hopper of a Kent ring grinder. In this mill there are three rolls, but the drive is through only one, the upper of the three. The ground coke discharged from this grinder is screened and the over-size returned for regrinding. The fine coke goes to the



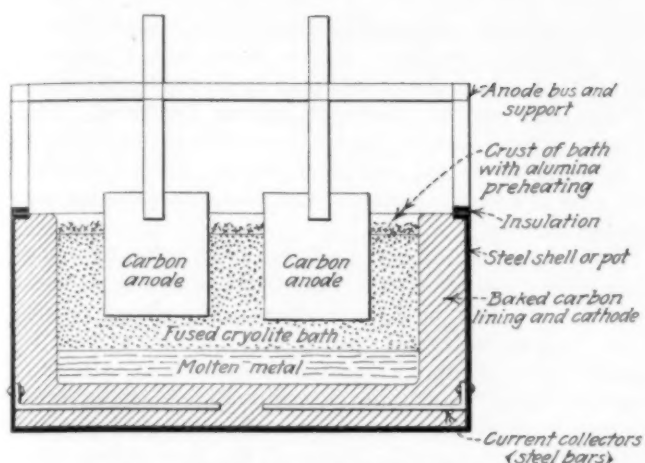


Fig. 3—Section Through Aluminum Furnace

The construction of these furnaces, the so-called "pots," is described fully in the text.

storage bin ready for use as the necessity arises.

Lump pitch which is used on a very large scale in the electrode manufacturing department is used in pot lining only to a limited extent. This pitch is broken up to suitable size and with the tar required to make a mix of requisite plasticity is mixed with the coke and blended in a specially designed steam-jacketed mixer. Fig. 6 shows the exterior of these blending mixers. It will be noted that they are of the double horizontal-paddle-shaft type. The feed to the mixer is brought in a small electrically driven larry car and dumped into the top through the chute seen in the picture.

When the plastic mass has been thoroughly blended in the mixer a suitable quantity is dumped into a pot shell in which the collector bars have previously been bolted in place. The mass is rammed in position around the collector bars and over the bottom by compressed air tampers. A cast-iron cavity form is then placed on this bottom and properly centered in the shell. An additional amount of the plastic material is then rammed in place around it. The lined shell with the form still in place is then run into a baking furnace and the lining baked in place. After baking and cooling the cavity form is removed and the completed pot is ready to be transported to the furnace room for use.

#### MANUFACTURE OF ELECTRODES

The major material used in electrode manufacture is petroleum coke. It is necessary to use such "ash-free" material because any metallic constituent of the ash in the electrode will appear in the aluminum unless electro-negative to that metal. Obviously, therefore, the specifications for the coke used are strictly enforced.

The petroleum coke received at the plant is dumped from cars into a track hopper and carried by a steel apron conveyor to the preliminary crushers. These are Jeffrey coal sizers with spiked rolls which break the coke down to the size desired with the manufacture of very little fines. The crushed coke which passes through the bar grizzly goes direct to storage, but the over-size passes through a second roll crusher before it is stored. A building about 150 by 420 feet in floor area is devoted almost exclusively to the storage of this sized petroleum coke. The supply is elevated at one end and carried along the peak of the roof on a belt conveyor with trippers arranged to discharge it on the pile at any point desired. As evidence of the care in planning details of this plant should be cited the fact that

the roof angle of this coke storage building was determined by the critical angle of piling for coke of the size and character which will be here stored. It is evident that the company does not propose to build a single cubic foot of storage space, even up next to the roof, which cannot be usefully employed.

As the coke is required for use it is reclaimed from storage by a Sauerman drag conveyor. The reclaimed coke is screened with a Pittsburgh vibrator screening system and the large and small coke are separately elevated by apron conveyors to storage bins in the calcining building. From these bins the desired proportions of large and small coke are withdrawn and remixed so that the feed to the calciners will always contain the same proportions of large and small material. This has been found to be a very important precaution to insure that the calcining furnaces will function uniformly.

These calcining furnaces are continuous vertical-shaft Hoopes electric calciners into which the coke is fed at the top and out of which the calcined material passes at the bottom by gravity discharge through a self-sealing hopper system. The gas generated during calcination, from the residual volatile matter of the coke and the small amount of combustion which takes place with the air unavoidably introduced, is withdrawn through an offtake at the top of the furnace shaft. A certain amount of this gas is recirculated through the shaft of the furnace to maintain uniform conditions within; the surplus goes to a small battery of coal-fired boilers where it is burned above the stoker grates. This gas is largely carbon monoxide and hydrogen and the useful heat of their combustion is thus conserved.

The calcined coke, which is discharged cold enough to prevent oxidation in the air, goes to small storage bunkers to which it is transferred after weighing by a hopper-bottom scale car. The discharge from these bunkers is through a coal-crushing unit of the corrugated-roll type. The crushed coke from the rolls is elevated to the grinding room bunkers which in turn feed the Kennedy-Van Saun rod mills which function as the last grinding unit in the preparation of the coke. The coke which passes through the screens at the outlet of the rod mills is elevated to the mixing-room bunkers, ready for use in the electrode manufacture. The over-size is returned to the rod mill feed for further grinding.

The second major material used in the electrodes is pitch. This is received in bulk at the plant by railroad car. It is dumped through track hoppers and a conveyor into a single-roll crusher system which breaks down the large pieces before the pitch goes into the storage bins. An entirely separate building is provided for pitch storage and this is isolated several hundred feet from all other plant buildings in order to minimize the plant fire and explosion hazards which are inevitable with this highly flammable material in dust form. As in the case of coke the pitch is reclaimed from storage by a Sauerman drag-line conveyor into the hopper of a belt conveyor system which carries it approximately 200 ft. from the storage building to the grinding plant. This plant is in a special separate wing of the electrode manufacturing building, the separation here being for safety reasons. The preparation at this point consists simply in breaking down the pitch in a Sturtevant crusher of the coffee-mill type. The fine pitch is then elevated to the mixing room bunker ready for use.

Although the electrodes are burned down at the furnaces to amazingly small dimensions the percentage

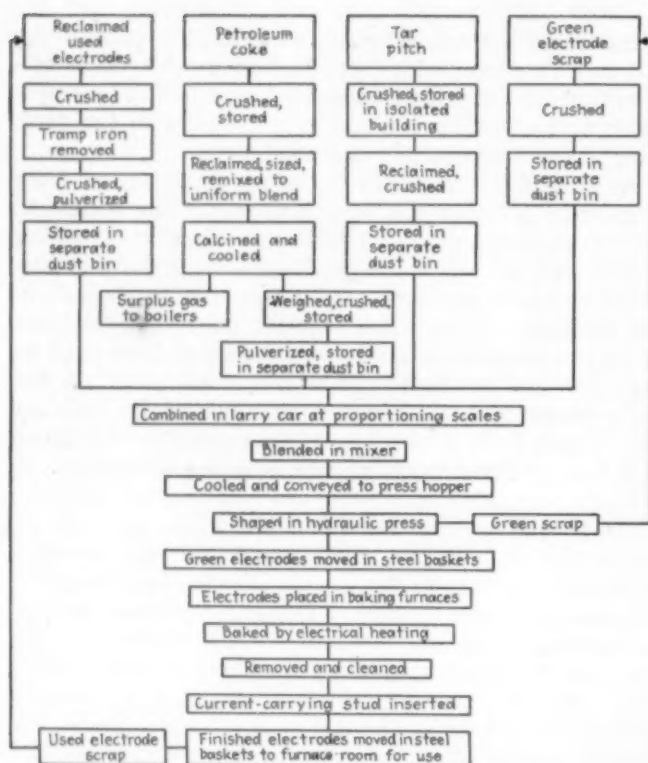


Fig 4—Flow Sheet of Electrode Plant

of the original which remains unused is well worth reclaiming. These pieces of electrodes are first broken free from their metal hangers and a rough sorting of metal and carbon made. Then the hangers return to the mounting room and the reclaimed carbon is transported by railway car to a track hopper at the electrode plant. The first treatment of this reclaimed material is passage through a Kennedy-Van Saun jaw and roll crusher shown in Fig. 7. The discharge from the crusher passes over a magnetic pulley in order to eliminate the iron, of which a surprisingly large amount is present. The metal-free carbon then passes to an Allis-Chalmers gyratory crusher and from this to an intermediate storage bin. This bin feeds the roll mill and screening system used for final crushing before the fine carbon, now ready for use, is elevated to the mixing-room storage bunker.

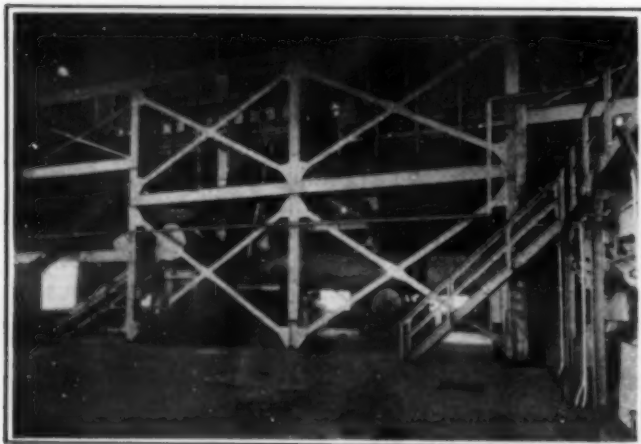


Fig. 5—Coke Grinding Machinery in Pot-Lining Building  
The coke enters from car or from storage by conveyor on left direct to pot-mill for first crushing; is elevated to storage bin (bottom shows in upper left); is fed to rotary drier (center); is elevated to dry coke storage (top center); is fed to ring grinder (not shown) and then elevated to final storage. From storage it is drawn out as needed for blending with pitch in mixers (extreme right).

Even the best managed electrode plant cannot make every electrode perfect. Hence there is a substantial quantity of green electrode scrap to be recovered at the presses and at the electrode baking furnaces. This "green" scrap must, of course, be reclaimed and reused. It is returned to the mixing building, passed through jaw and gyratory crushers, and elevated into its own storage bunker.

There are, as indicated above, four solid materials to be mixed and blended for electrode production. These four are crushed petroleum coke, finely ground pitch, finely ground reclaimed used electrodes, and ground reclaimed green scrap. These four materials are stored in four adjoining "dust" bins shown in Fig. 8. From these storage bunkers they are drawn off as needed through automatic proportioning scales of the Richardson type. The discharge from the scales is into an electrically driven larry car (shown in Fig. 9) which receives the four materials from the scales automatically in predetermined proportions. Obviously these proportions, especially of pitch, coke, and used scrap, must be carefully maintained. The quantity of green scrap in any batch may, however, be varied widely according to the



Fig. 6—Steam Jacketed Mixers in Pot-Lining Building  
Ground coke, tar and pitch are blended in these mixers and then tamped into the pots to form a lining.

amount on hand, as this green scrap contains the other three constituents already proportioned in the desired ratio.

When the larry car has received its charge of the various materials it is run over the hopper of one of the mixers, which are almost identical in form with those previously described for blending the pot-lining mixture. When the mixture has been properly blended in these steam-jacketed devices it is discharged upon a series of belts, shown in Fig. 10. The discharge from this belt system is a conveyor which takes the material directly to the press hopper.

The green electrodes which discharge from the press are placed in big sheet-steel baskets. These baskets are moved by crane from the press side to the electrode-baking furnace. Fig. 11 illustrates the long tunnel-like character of these furnaces, two of which are shown nearing completion and others at various stages of construction. The furnaces are about 10 x 10 x 200 ft. inside, with open tops so that the crane can drop a basket of green electrodes directly into the furnace; thence workmen place them in tiers by hand and fill in the chinks around and between them with fine petroleum coke.



The baking of the electrodes is done electrically by the passage of a heavy current through the entire electrode mass from one end to the other of the furnace. Thus the electrode mass itself forms the resistor and heating element of the furnace. When the baking operation is complete and the furnace has cooled down to the point that it can be entered, the electrodes are removed and cleaned by hand and stacked into sheet steel baskets. An overhead crane then moves them by the basketfull into an adjoining section of the building where they are "rodded." This operation of rodding consists in fastening into the opening at the top of the electrode the metal conductor by which it will be hung and mounted in the furnace.

After rodding, the electrodes are again loaded in baskets which are placed on flat cars and moved from the electrode plant to the furnace rooms. It should be noted that the cars so employed are full-size railway rolling stock. The policy of using such big units throughout this plant may at first seem strange, but when one realizes the thousands of tons of materials which must be moved each day he understands that smaller narrow-gage units would be quite out of place

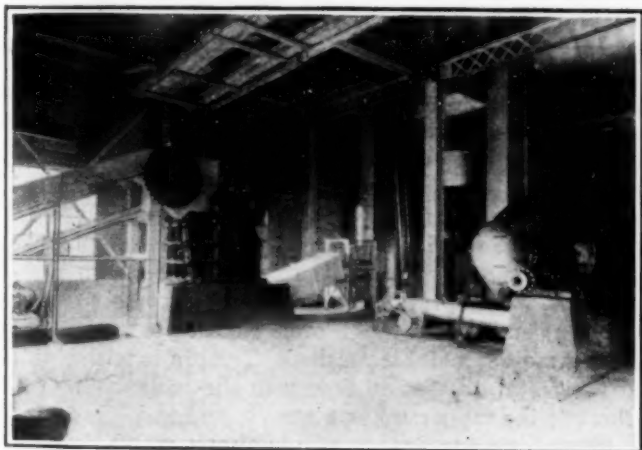


Fig. 7—Equipment for Grinding Scrap Electrodes

Jaw crusher, gyratory and rod mill (left to right) are used in succession for grinding the reclaimed electrode material. The bottoms of the storage bins show above. Elevators and conveyors carry the material at all stages.

here. But even when one realizes this, it still does seem strange to find standard gage railway trackage and cars both indoors and out almost everywhere throughout the plant.

#### MAKING ALUMINUM

In a single furnace room at Arvida there are over a hundred single furnaces or pots, and there are to be 40 such furnace rooms. Within each room the entire group of pots is run electrically in series. Thus the voltage across any single pot is only about six volts and the insulation problems are correspondingly simple.

To start up such a furnace room is a great achievement in itself. To do this requires the most thorough preparation and the greatest skill on the part of the operating force. But after the group of pots is well in operation the furnace room takes on an air of easy-going that one might almost call indolence. As a matter of fact the more running around by the operatives and the more evidence of activity on the part of the furnaces themselves the less is the management pleased. The best behaved and most productive furnace is actually the one which seems to be doing nothing at all.

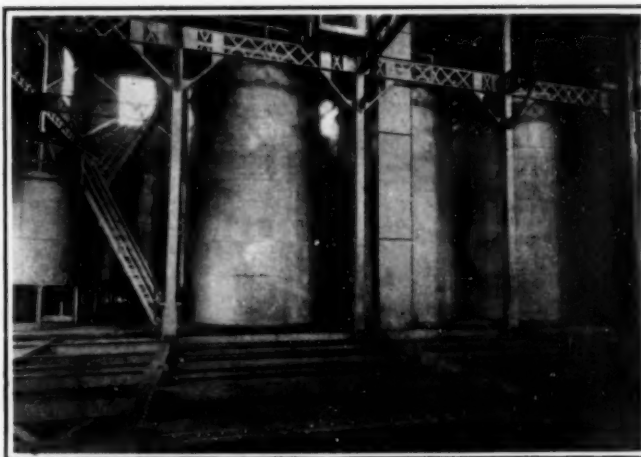


Fig. 8—Dust Bins in Mixer Building

Ground petroleum coke, pitch, reclaimed used scrap and reclaimed green scraps are stored separately as "dust" in these bins.

As the electrolysis proceeds the concentration of alumina dissolved in the cryolite decreases. Finally the concentration reaches a point at which the well-known "anode effect" takes place. The conditions which produce this effect vary considerably with temperature, with anode current density, and with other complicated factors; hence the concentration of alumina at which it occurs is not always the same. But when it does occur the results are always the same; the resistance of the furnace rises sharply and the voltage across the furnace jumps to several times its normal value. The electrolyte will no longer "wet" the anodes and they appear to be surrounded by a gaseous film through which an arcing of the current takes place. It is extremely important to insure that this anode effect is made of the very minimum duration on any pot. Hence a system of signal lamps has been arranged at the Arvida works so that a light immediately shows when the anode effect begins and this gives a signal to the operator that the furnace must be "worked." When this signal is observed the furnace man breaks in the crust of frozen electrolyte with a crow-bar and stirs into the bath the alumina which has been pre-heating on the crust. As the alumina is stirred into the bath it dissolves, increasing the concentration to the point at which the anode effect again disappears. This is evidenced by the fact that the signal light goes out. The operator then

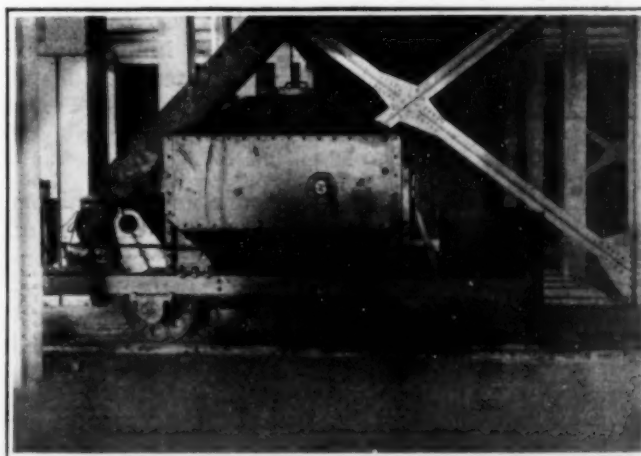


Fig. 9—Electrically Driven Dust Car

Properly proportioned mixtures of coke, pitch and reclaimed scrap are mixed as dust in these cars through automatic proportioning scales. The car discharges into steam jacketed mixers similar to those used for blending pot-lining materials.





Fig. 10—Interior of Mixer Building

The charge from a mixer (top center) after blending passes through a chute (right center) onto a series of conveyor belt that carry it to the electrode presses.

makes any needed anode adjustments, replaces anodes which have been used up, and finally spreads a small quantity of powdered alumina on top of the newly formed crust where it will preheat, ready to be stirred in at the next "working."

It is possible to dissolve nearly 20 per cent of alumina in molten cryolite, but this concentration cannot be approached in practice, because the rate of solution is slow and there is great danger that undissolved alumina may settle through the electrolyte to the bottom of the furnace. In practice, therefore, it is necessary to keep the maximum concentration of alumina in the bath low. As a result the anode effect occurs at frequent and almost regular intervals; in fact it is an evidence that the furnace is not functioning properly if an anode effect on it does not occur at the usual interval.

A furnace man to do his work properly must have a considerable degree of skill and experience. Especially is it important that the adjustment of all of the anodes be accurately and carefully made. If one electrode be higher or lower than another it does not function normally and there is danger that the productivity of that furnace will be lowered or that the anode consumption by burning will go up unduly. Furthermore, the power input to an individual furnace and to the series of furnaces in any one room is controlled largely by means of the anode adjustments. The man who can operate a series of furnaces in such a way as to keep the current uniform and within narrow limits and all of the furnaces at the proper working temperature is indeed an artist in his line.

#### POWER AND ELECTRODE CONSUMPTION

Theoretically the reaction for production of aluminum requires the consumption of two-thirds of a pound of carbon per pound of aluminum made. The actual consumption is, of course, greater, both because the electrodes burn in the air above the bath to some extent and because it is impossible to reclaim completely all parts of electrodes which are not burned up in the furnace. Hence in practical operation the electrode consumption is at least three-fourths of a pound of carbon per pound of aluminum made, and most plants use the traditional ratio of "a pound of carbon burned per pound of aluminum made."

In theory it requires only approximately five kilowatt-hours of power to electrolyze out of a bath each

pound of aluminum. Obviously, however, the current has much to do in the way of heating as well as electrolytic action. The actual power consumption at Arvida is, of course, not yet established, as this plant has been operating only a very brief time. The figures usually given in the literature for power consumption are 12.5 to 13 kilowatt-hours consumed per pound of aluminum made.

Efficiency in the furnace room which, of course, means low cost production, depends not alone upon electrode consumption and power efficiency. It depends also very largely upon the output in pounds of aluminum per pot per day. One of the great problems of works management is, therefore, to increase the productivity of any group of pots. At Arvida this has been attempted by a labor bonus which goes to the workmen on any given group in accordance with the pounds of metal produced per 24 hours per pot under their control. This scheme has been a great success; in the terms of the management referring to the furnace men: "They now do the impossible." And this "impossible" is achieved only by greatest care in maintenance of electrode levels, proper feed of ore, sufficient, but not too much, stirring, and above all, alertness and good house-keeping in the furnace room.

#### TAPPING OF FURNACES

The aluminum which collects in the bottom of the furnace cavity is tapped out at regular intervals of one, two, or three days, into a ladle which is set for this purpose into a recess in the floor in the front of the tap hole in the furnace. Tapping is generally done by a special crew of men who do not otherwise participate in the regular work of the furnace men. The tapper drives a steel pin through the tap hole with a sledge hammer, penetrating the frozen electrolyte and metal until the molten metal is reached. The pin is withdrawn and the metal allowed to flow into the ladle. While it is flowing the tapper takes a sample and inspects it for the crystalline appearance of aluminum which is high in iron. When this is noted it indicates the failure of the furnace lining.

When the desired amount of metal has been drawn from the furnace, as evidenced by the appearance of molten bath at the tap hole, the tap hole is closed with a wooden or steel plug. The molten metal is transferred from the tapping ladle to a larger pouring ladle, the metal from several furnaces being here mixed and



Fig. 11—Carbon Baking Furnaces

Two furnaces are shown nearing completion. Three others, shown at earlier stages of construction will form a part of this group which fills half of one baking building.

skimmed to form a single cast. It is poured from this "pouring ladle" into cast-iron or steel pig molds, each of about 50 pounds capacity. The molten metal is again skimmed in the pig mold before it solidifies.

All of the pigs from a single pouring-ladle batch when cooled are stamped with the same cast number, removed from the molds, and stacked in racks for transportation to storage by trucks, usually of the elevating platform type. A sample from each cast is sent to the laboratory for analysis, to determine silicon, iron, and copper, and occasionally other elements. As soon as the analysis is reported the pigs from that cast are marked as to grade, thus indicating to the remelting department the class of metal for which that cast is best suited. Incidentally, uniformity in composition for any particular grade of commercial metal can only be obtained by remelting. In this operation the removal of non-metallic impurities, dirt, slag inclusions, etc., is also accomplished. At Arvida, however, the original pigs represent the finished product of the plant at the present time; arrangements for remelting will be made later.

#### CAPACITY AND FUTURE OF ARVIDA

It is hard to visualize the size and capacity of the Arvida plant. Perhaps this can best be done in terms of output as compared with present world production. It has been estimated that the 1925 world production of primary aluminum was 150,000 tons. At Arvida each kilowatt year used will produce about 700 pounds of metal; thus capacity production, using all of the power from Chute-a-Caron, would give almost 300,000 tons per year from the Arvida plant, or twice the present world output.

The Arvida plant is itself an object lesson in the use of aluminum not only for conductors but also as sheet for ventilators and as paint. Most of the mechanical units and much of the structural steel about the plant glitters with this paint, adding greatly to the appearance of good housekeeping as well as to the probable life of the metal so protected.

Frary has pointed out that great developments in aluminum use can be anticipated. He estimates that if all automobile manufacturers used as much aluminum per car as European builders, the consumption for automobiles alone would be greater than the total present world production. And, of course, everyone realizes that there will be great increases in sales for sheet and castings in the railway and other engineering fields, for cable to be used in high-voltage transmission lines, for rod, wire, and shapes generally, and for a multitude of little uses among the more prominent of which are aluminum paint, aluminum foil, and aluminum collapsible tubes.

None of these uses alone is likely to keep Arvida busy at its projected capacity, but collectively they represent a great growth and promise for the business. It seems evident, indeed, that the vision of the company, the executive skill of its president, and the technical achievements of its engineers, all factors in the successful creation of Arvida, will be fully utilized in supplying the growing markets for light metals.

#### ACKNOWLEDGMENT

The courtesies extended and assistance given by various members of the staff of the Aluminum company have been invaluable and are gratefully acknowledged. Without the cordial cooperation accorded, this and the preceding article would not have been possible.

## Extinguishing Carbon Bisulphide Fires

Carbon bisulphide is probably the most hazardous liquid used in manufacturing processes to day. It can be ignited when at temperatures as low as  $-20$  deg. F., and when heated to only 300 deg. F. it ignites itself. A fire once started is very difficult to control, the ordinary methods of extinguishing being practically worthless and the choking fumes of sulphur dioxide given off making approach difficult unless there is ample ventilation. Furthermore, the vapors of carbon bisulphide are explosive, so that an additional serious hazard is present when this liquid is used in a confined space.

Tests to determine the value of various extinguishing agents on fires in this material were made recently at the Everett Testing Station, which is maintained by the Factory Mutual Laboratories. Practical conditions were approximated by igniting carbon bisulphide in open tanks, and attempts were made to put out the fires with various extinguishing agents.

Sawdust and soda mixture, a good extinguisher for fires in most hazardous liquids, was found to be ineffective until enough of the material had been added to absorb all the liquid. Even then vapors continued to pass through a blanket of sawdust and burn.

Carbon tetrachloride did not extinguish the fire even after a quantity equal to the amount of carbon bisulphide had been added. In view of the large amount of carbon tetrachloride which would be required, it is not considered a suitable extinguishing agent, except in enclosed spaces, where the inert atmosphere produced can be maintained.

Foam had little cooling effect, and although it greatly reduced the severity of the fire for a time, it could not be depended upon as a positive extinguishing agent, because vapors of carbon bisulphide penetrated the foam blanket and continued to burn at the surface.

Water from automatic sprinklers or from hose streams is ineffective because of the splashing which takes place. This increases the intensity of the fire and may force the burning liquid over the sides of the tank and so spread it over a large area.

The most effective method was found to be by the use of water allowed to flow quietly into the burning material from a low pressure hose stream, or admitted to the liquid at moderately low pressures through a perforated pipe below the surface. The important thing is to apply the water, which is lighter than carbon bisulphide and does not mix with it, so that no splashing occurs. The water collects on the surface and extinguishes by a blanketing rather than a cooling action, although the cooling action is probably sufficient to lower the temperature below its boiling point.

It is apparent that carbon bisulphide should be used inside main buildings only when absolutely necessary, and then only in small quantities. Processes involving its use should be located in outside detached buildings. Open tanks of the liquid should be equipped with perforated pipes at the bottom, with feed pipes of a diameter small enough so that the water will be delivered at low pressure and will not break the surface of the liquid. The controlling valve should be located in an easily accessible location some distance from the tank.



## Properties of Sodium Cyanide Copper Solutions

Optimum molal ratio of cyanide to copper determined; stirring and gas agitation studied

By Walter D. Bonner and Bal Dev Kaura

The University of Utah

AN IMPORTANT consideration in the electrodeposition of metals would seem to be the composition of the electrolyte, yet there is at the present time surprisingly little exact information available on the subject. It seems impossible to say whether the electrolyte may be made up from any salt of the metal and any cyanide, or whether certain metal salts or certain cyanides are preferable to others. The proper ratio of cyanide to metal is likewise uncertain.

Most plating formulas specify cupric sulphate, or cupric acetate. It should be pointed out again, as Blum and Hogaboom [Blum and Hogaboom, "Principles of Electroplating and Electroforming," p. 202. McGraw-Hill Book Company, Inc., New York (1924)] have already done, that the use of any cupric salt is wasteful of cyanide and may become dangerous. A large portion of the cyanide necessary, perhaps as much as 30 per cent is used in reducing the cupric salt to cuprous. This amount of cyanide is converted into cyanogen, which may escape from the solution in sufficient quantity to be dangerous. At least two cuprous salts are available for the preparation of plating solutions, cuprous cyanide and cuprous chloride, and cuprous oxide may also be used. Any of these will dissolve in sodium or potassium cyanide solution without formation of cyanogen and hence without waste of cyanide. Of the three compounds mentioned, the cyanide would seem, at first thought, to be preferable. No unnecessary cation is introduced into the solution, and less alkali cyanide is required to convert it into the cupro-cyanide complex than is needed for either of the other two. It has been found that the ratio of mols of bound cyanide, that is cyanide which cannot be titrated with silver nitrate, to mols of copper is, in these sodium cyanide solutions, about 3 at all concentrations of copper, when the copper is in the form of cuprous cyanide. When cuprous chloride is the dissolved salt this same ratio approaches 4 at low concentrations of copper, decreasing with increasing copper content but never falling below 3.3. For solutions made from cuprous oxide, the ratio is between 3.5 and 3.2. This means, of course, that cuprous cyanide is more soluble in sodium cyanide solution than is cuprous chloride or cuprous oxide. It has been found that molal sodium cyanide solution will dissolve 31 gm. of copper per liter from cuprous cyanide, 25.5 gm. of copper per liter from cuprous oxide, but only 19 gm. of copper per liter from cuprous chloride.

### COMPARISON OF VARIOUS ELECTROLYTES

On the other hand sodium cyanide solutions of cuprous cyanide and cuprous oxide are so susceptible to atmospheric oxidation that much free cyanide must be maintained in them. When no excess cyanide is present, that is when the solutions are saturated with the copper salt, the solutions quickly turn blue and deposit solid salts, cuprous cyanide being deposited by

the one made up from that salt and cupric hydroxide being deposited by the other. Even when a large excess of free cyanide is present, current efficiencies are less with these solutions than with the cuprous chloride solution. This may be due to anodic oxidation, but on this point there is no evidence. However, the general conclusion is that electrolytes using cuprous chloride for the copper salt are preferable, they being more stable and yielding higher current efficiencies. They are also superior to electrolytes made from copper sulphate, as under similar conditions they give a markedly higher current efficiency.

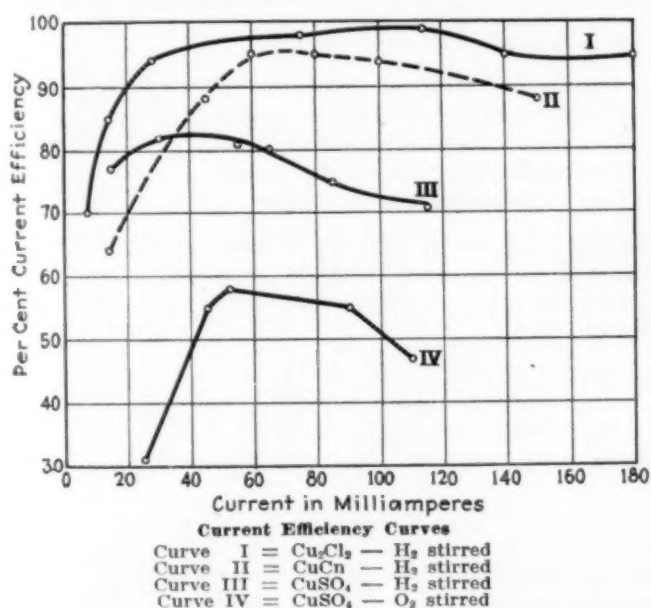
It has also been found that the molal ratio of cyanide to copper must not exceed 5. For a solution molal in sodium cyanide there must be present not less than 13 gm. of copper per liter. When the bath contained 12 gm. of copper or less, not only was no copper deposited at current densities below that at which cyanogen was evolved, but the copper-plated cathode actually lost copper to the bath. This of course is to be expected. It has long been known that alkali cyanide solutions will dissolve metallic copper, but this reaction has been thought to be due to dissolved oxygen. Kunschert, however [Kunschert, *Z. Anorg. Chem.*, vol. 41, p. 359 (1904)] showed that this is not due to oxygen, but that metallic copper dissolves readily in oxygen-free cyanide solutions. When the amount of copper is less than one mol to each 5 mols of cyanide, this dissolving reaction is faster than the deposition.

The high ratio of cyanide to copper in these solutions, and the fact that the ratios vary and are different from solution to solution, are worthy of note. It is commonly stated in textbooks [see, for example, Blum and Hogaboom, *loc. cit.*, p. 200; Holleman, "Inorganic Chemistry," 6th Ed., p. 365, John Wiley & Sons, New York (1921); "General Chemistry," Joint Authors, p. 625, Miner Publishing Company, Macomb, Ill. (1926)] that the compound produced when the blue color of a copper solution is destroyed by cyanide, corresponds to the ion  $\text{Cu}(\text{CN})'_2$ . Rammelsberg, and Schiff and Becchi, have shown [Rammelsberg, *Pogg. Annal.*, vol. 42, p. 124 (1837); vol. 73, p. 117 (1848); vol. 106, p. 491 (1859); Schiff and Becchi, *Annal.*, vol. 138, p. 35 (1866)] that the following solid salts can be prepared;  $\text{KCu}(\text{CN})_2$ ;  $\text{KCu}_2(\text{CN})_3 \cdot \text{H}_2\text{O}$ ;  $\text{K}_2\text{Cu}(\text{CN})_4$ . It is probably from this work that the idea of the simple ion  $\text{Cu}(\text{CN})'_2$  has got into the literature. However, Treadwell and v. Girssewald [Treadwell and v. Girssewald, *Z. Anorg. Chem.*, vol. 38, p. 92 (1904)] have shown by a titration method that in solution the ratio of cyanide consumed to copper present is generally 4, though sometimes 3, and Kunschert [Kunschert, *Z. Anorg. Chem.*, vol. 41, p. 359 (1904)], by a method involving the e.m.f. of concentration cells, has shown that the ion present in solutions of cuprous cyanide in potassium cyanide are  $\text{Cu}(\text{CN})'''$ , and  $\text{Cu}(\text{CN})''$ , the latter being the less prominent. Our own results show that with solutions made from cuprous cyanide and sodium cyanide, the complex ion is almost exclusively  $\text{Cu}(\text{CN})'''$ . With the other solutions the proportion of this ion present is small at low copper concentrations but increases with increasing copper content of the solution. It would seem, also, that the relative amounts of these two ions depends somewhat on the nature of the other anions present in the solution. This latter point has not been investigated further, because of analytical difficulties. No satisfactory method for



determining the total cyanide content of a solution containing so stable a complex ion as the cuprocyanide ion has been found.

Another important matter about which little seems to be known, is the effect of stirring or agitating the bath. It seems generally conceded that agitation would be beneficial. Thus Langbein [Langbein, "Electrodeposition of Metals," 8th American Ed., pp. 294 and 708, Henry Carey Baird & Company, New York] advocates it but at the same time points out certain disadvantages. Blum and Hogaboom [Blum and Hogaboom, *loc. cit.*, pp. 87 and 179] likewise favor the practice. On the other hand, agitated baths are the exception rather than the rule in the electroplating industry. In the present work ordinary mechanical agitation was discarded as too cumbersome and too difficult to apply. Agitation was obtained by means of streams of gases led into the solutions. Blum and Hogaboom [Blum and Hogaboom, *loc. cit.*, p. 88] point out that air agitation in cyanide baths favors the



formation of carbonates. This means, of course, loss of cyanide, as  $\text{HCN}$ , since carbonic is the stronger acid, and eventually the deposit of solid cuprous cyanide in the bath. It has been found also that the use of oxygen, or air, in the bath, even when carefully freed from  $\text{CO}_2$ , quickly causes the bath to turn blue, thus indicating oxidation of copper. This oxidation also is accompanied by loss of cyanide, and eventually by the deposit of cuprous cyanide. The effect of air or oxygen is especially noticeable on the current efficiency. In a bath which gives, when agitated with hydrogen, a current efficiency of 98 per cent, the current efficiency decreases at once to 60 per cent when oxygen is substituted for the hydrogen. Mechanical stirring, because of the beating of air into the solution, would probably also result in a decreased current efficiency. The current efficiency is markedly improved by agitating the bath with any reducing or inert gas. Probably it is simply the exclusion of air which provides the favorable condition. Thus it has been found that hydrogen, nitrogen and coal gas when freed from  $\text{CO}_2$ , are equally effective in raising the current efficiency.

All plating experiments were carried out at 25 deg. C. A Pyrex beaker served as the plating bath. The beaker was provided with a wooden cover, through

**Table I—Sodium Cyanide and Cuprous Cyanide**

Bound Cyanide, Mols per Liter	Copper, Mols per Liter	Ratio
1.144	0.00	...
0.149	0.049	3.04
0.341	0.107	3.18
0.791	0.244	3.24
0.869	0.267	3.24
1.036	0.324	3.20
1.434	0.442	3.24
0.712	0.000	...
0.166	0.052	3.19
0.193	0.063	3.06
0.272	0.090	3.02
0.512	0.169	3.03
0.560	0.179	3.12
0.902	0.288	3.13

**Table II—Sodium Cyanide and Cuprous Chloride**

Bound Cyanide, Mols per Liter	Copper, Mols per Liter	Ratio
1.008	0.000	...
0.229	0.063	3.64
0.417	0.128	3.26
0.646	0.198	3.26
0.854	0.262	3.26
1.008	0.304	3.29

**Table III—Sodium Cyanide and Cuprous Oxide**

Bound Cyanide, Mols per Liter	Copper, Mols per Liter	Ratio
1.245	0.000	...
0.228	0.065	3.51
0.435	0.136	3.20
0.660	0.202	3.26
0.845	0.263	3.34

which were passed the iron cathode, the two copper anodes and the glass tube through which the gases for agitation were led into the bath. The copper-plated iron cathode, 5x5x0.18 cm., was placed symmetrically between two copper anodes of the same size and shape. A silver coulometer was placed in the circuit. The source of e.m.f. was a 6-volt storage battery. In determining current efficiencies with various solutions 400 c.c. of the solution was placed in the bath, and, all adjustments being made, the electrode assembly was dropped into the bath, and the stopwatch started. Current was allowed to pass for a length of time sufficient for 125 to 150 coulombs, when the current was interrupted by removing the electrode assembly from the bath. The cathode was then washed with water, with alcohol and with ether, after which it was weighed. The anodes were likewise washed and weighed. Similar experiments, using the same solution but gradually increasing current densities, were carried out until the current efficiency began markedly to decline, and the deposits became notably non-adherent. Analyses were confined to the amount of copper in the solutions and the amount of free, or excess, cyanide. The copper was determined by the usual iodide method, after first ridding the solution of cyanide by evaporating with nitric acid, adding excess ammonia and making acid with acetic acid. Free cyanide was determined by direct titration with standard silver nitrate solution, a few crystals of potassium iodide being added near the end point.

## Sulphur Compounds in Petroleum

Dr. E. Emmet Reid of the Chemical Laboratory, Johns Hopkins University, announces that Dr. Parry Borgstrom has been obtained to direct research on the identification of sulphur compounds in petroleum and its products, an investigation that is being financed by John D. Rockefeller and the Universal Oil Products Co. through the American Petroleum Institute. A literature survey of the chemistry of the simpler sulphur compounds with reference to their separation and identification has been made. The next step will be a study of these reactions on selected sulphur compounds. Suggestions as to the conduct of this research will be welcomed.

# Studies on Mechanism of Filtration

Determination of filtration constants for calcium carbonate and calcium sulphate sludges under varying conditions

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IN THIS paper, an attempt has been made to determine the filtration constants for calcium carbonate and calcium sulphate, to note the effect of the filtration variables on these constants and to compare the different equations proposed for filtration design with regard to their accuracy and adaptability, both for the determination of the constants and in the design of filtration units.

Calcium carbonate and calcium sulphate were selected for three reasons. First, they are among the most common sludges appearing in commercial processes. Second, these sludges were chosen because of the ready availability and low cost of the chemicals used in their preparation. Third, they are representative of "incompressible" sludges.

## REVIEW OF LITERATURE ON FILTRATION

In 1908, E. Hatschek [*J. Soc. Chem. Ind.*, vol. 27, p. 538 (1908)], discussed the mechanism of filtration. Interesting conclusions are drawn, but the paper is purely theoretical and applies only to incompressible sludges.

The first study of filtration from the chemical engineering viewpoint was probably made by C. Almy, Jr., and W. K. Lewis [*J. Ind. Eng. Chem.*, vol. 4, p. 526 (1912)] on a sludge of chromium hydroxide. They concluded that the facts were expressed by the equation

$$R = K \frac{P^n}{V^m} \quad (a)$$

where  $K$ ,  $m$ , and  $n$  are unknowns which must be determined experimentally for each sludge,  $V$  is the volume of the filtrate which is directly proportional to the thickness of the filter cake,  $P$  is the pressure and  $R$  the rate of filtration.

In 1914, J. W. Bain and A. E. Wigle [*Ibid.*, vol. 6, p. 672 (1914)] concluded that the rate of flow of a liquid through a filter mass of finely-divided solid, under constant head, will obviously be dependent upon the amount of space not occupied by the grains, or what is commonly known as the "pore space." The "pore space" is almost independent of the size of the grains, but the shape and arrangement of them is of chief importance.

J. J. Eastick [Bühler and Eastick, "Filters and Filter Presses," Norman Rodger, London, p. 104 (1914)] concluded that irregularity of the particles causes retarding of filtration. He also states that viscosity influences the rate of filtration and that the rate of flow is greatly influenced by the areas of the pores in the precipitate.

The equation derived by D. R. Sperry [*Met. & Chem. Eng.*, vol. 17, p. 161 (1917)] in 1917 is decidedly complex, and consequently is not well suited for design. This equation is based on small-scale experiments which were not comparable to commercial filtration. It is prob-

ably due to this that the results of Sperry and those of Baker do not agree. Sperry states that upon plotting his results, it was evident that the rate of flow varied as the first power of the pressure.

The work of Fred P. Baker [*J. Ind. Eng. Chem.*, vol. 13, p. 610 (1921)], in which plant-scale equipment was used, further substantiated that of Almy and Lewis when their formula was applied to his results. Baker derived his formula from that of Lewis in the following manner:

$$R = \text{rate of flow} = \frac{CAP^n}{L} \quad (c)$$

$A$  = area of filtering surface in square feet.

$P$  = pressure in pounds per square inch.

$C$  = proportionality factor.

$n$  = constant depending on sludge.

$L$  = thickness of cake in inches.

As the thickness of the cake is directly proportional to the volume of the filtrate,  $V$ , providing there is no change in the concentration of the solid matter in the sludge, then

$$LA = \alpha V$$

$$L = \frac{\alpha V}{A} \quad \text{where } \alpha \text{ is the proportion of solids in sludge.}$$

$$\text{Substituting } R = \frac{CA'P^n}{\alpha V} \quad \text{And if } \frac{C}{\alpha} = K$$

$$R = K \frac{A'P^n}{V} \quad (d)$$

It was found that the rate of flow was not always inversely proportional to the first power of  $V$ , but rather to some function  $V^m$ .  $m$  was later found to vary between 0.8 and 1.2, depending on the sludge. Thus the final equation is:

$$R = K \frac{A'P^n}{V^m}$$

The flow through a filter cake is a capillary phenomenon, and it is well known that any change in the size of the capillary openings of the cake will greatly affect the rate of flow. Baker also derives his formula from Poiseuille's formula for flow through a capillary tube.

$$V = \frac{K_1 A \pi r^4 P}{8 \mu L} \quad (e)$$

$\mu$  = absolute viscosity.

$V$  = velocity of flow =  $R$ .

$r$  = radius of capillary tube.

$K_1$  = number of capillaries per unit area.

$L$  = length of tube.

By substituting  $C$  for the expression  $\frac{K_1 \pi r^4}{8 \mu}$  we have the expression:

$$R = \frac{CAP}{L}, \text{ or when } K_1 = \frac{C}{\alpha} \text{ as in equation (d)}$$

$$R = \frac{K_1 A' P}{V}, \text{ and upon further correction,}$$

Abstracted from a thesis presented by Ernest E. Jewett to the faculty of the Graduate School of the University of Minnesota in partial fulfillment of the requirements for the degree of Master of Science in Chemical Engineering.



depending upon the sludge:  $R = K \frac{A^2 P^n}{V^m}$  (f)

which is the same as that derived by Lewis.

The values of  $m$  and  $n$  are determined mathematically in the following manner: The equation

$$R = \frac{dV}{d\theta} = K \frac{A^2 P^n}{V^m}$$

simplifies to  $V^m dV = K A^2 P^n d\theta$

which, for constant pressure filtration, since  $A$  is also constant, may be written as

$$V^m dV = K_1 d\theta$$

$$\text{Integrating, } \frac{V^{m+1}}{m+1} = K_1 \theta + C$$

When  $\theta = 0$ ,  $V = 0$ , and  $C$  must be zero, so we have:

$$V^{m+1} = (m+1) K_1 \theta \quad (g)$$

By assuming different values for  $m$  until one is found which will give a straight line on a  $V - \theta$  plot of this equation, the true value of  $m$  is obtained.

By changing the method of filtration from constant pressure to constant rate, the equation

$$R = K \frac{A^2 P^n}{V^m}$$

becomes

$$V^m = K_2 P^n$$

where

$$K_2 = \frac{KA^2}{R}$$

Taking the logarithms of both sides, we have

$$m \log V = \log K_2 + n \log P \quad (h)$$

Since  $\log K_2$  is a constant, by plotting  $\log V$  against  $\log P$ , the slope of the curve is  $\frac{n}{m}$ , and knowing  $m$ ,  $n$  can be calculated.

H. I. Watermann and J. P. M. Van Gilse [*Rec. Trav. Chim.*, vol. 43, p. 757 (1924)] published an article "Determination of the Filtration Constants for Carboraffine and Norit." In their calculations of the constants, they used the formula of Lewis and Almy:

$$R = K \frac{A^2 P^n}{V^m}$$

The experiments were carried out on a small scale, using volumes of from 200 to 500 c.c.  $m$  was found by filtering two different volumes under identical conditions.

From equation (g):

$$\frac{V_1^{m+1}}{m+1} = K_1 \theta_1$$

Then,

$$\frac{V_1^{m+1}}{V_2^{m+1}} = \frac{\theta_1}{\theta_2}$$

Taking the logarithms of both sides and simplifying:

$$m+1 = \frac{\log \theta_1 - \log \theta_2}{\log V_1 - \log V_2} \quad (i)$$

$n$  was found by filtering the same volume at two different constant pressures,  $P_1$  and  $P_2$ ; two different times,  $\theta_1$  and  $\theta_2$ , being required. Removing  $P$  from the constant  $K_1$  of equation (g):

$$\frac{V^{m+1}}{m+1} = K_2 P_1^n \theta_1 = K_2 P_2^n \theta_2, \text{ since } V \text{ is the same.}$$

Taking the logarithms of both sides of the equation and simplifying:

$$n = \frac{\log \theta_1 - \log \theta_2}{\log P_1 - \log P_2} \quad (j)$$

Since the present paper was completed, an interesting article by Hinchley, Uri and Clarke has appeared [*J. Soc. Chem. Ind.*, vol. 45, p. 1T (1926)]. The authors study the formation of cakes of magnesium and calcium carbonates, barium phosphate and aluminum hydroxide

and test Hatschek's conclusions. They apply a modified form of Sperry's equation [*Met. Chem. Eng.*, vol. 17, p. 161 (1917)] similar to that used by Alliot [*J. Soc. Chem. Ind.*, vol. 39, p. 261T (1920)]. Their time-volume curves for calcium carbonate are similar to those found in this investigation. The apparatus employed was a small suction filter. For comparison, some experiments were made with a 5-in. plate-and-frame filter press.

The derivation of the equation of Lewis and Almy appeared in a recent paper by Weber and Hershey [*J. Ind. & Eng. Chem.*, vol. 18, p. 341 (1926)]. Experiments on a commercial unit for defecated sugar solutions are described. Weber and Hershey conclude that the equation is generally valid, but that its chief use is to determine whether a proper quantity of filter aid is being used.

#### DISCUSSION OF RESULTS

In this investigation, a thorough study has been made of calcium carbonate and calcium sulphate sludges, the equation of Lewis and Almy has been applied, and the constants  $m$ ,  $n$  and  $K$  determined under varying conditions of pressure, concentration of sludge, viscosity and surface tension of filtrate. The effect of these various conditions on the constants has been studied.

Two methods of calculating the constant  $m$  were available; that used by Baker [*J. Ind. Eng. Chem.*, vol. 13, p. 610 (1921)], and that employed by Watermann and Van Gilse [*Rec. Trav. Chim.*, vol. 43, p. 757 (1924)]. Both methods required a single filtration at constant pressure. Baker's method proved to be inconvenient for compressible sludges, since several trial substitutions must be made. But it has been shown by Lewis and Almy that the value of  $m$  lies between 0.8 and 1.2 which greatly limits the number of necessary trials and the method was found to be accurate. The other method was found to be much less accurate because it involved the quotient of two logarithmic differences and a slight error in reading any value of either  $V$  or  $\theta$  was thus greatly increased in the calculations. A comparison of the values of  $m$  obtained by both methods is given in Table I and illustrates the greater accuracy of the graphical method. The method of Baker was therefore chosen for the calculation of the constant  $m$ .

Table I—Calculation of Constant  $m$

Graphical (Baker)	Mathematical (Watermann and Van Gilse)
1	-0.055
1	-0.313
1	0.0
1	0.64
1	0.94

The most important data collected in the constant pressure filtrations is summarized in Fig. 1. The graphical calculation of the constant  $m$  for calcium carbonate is shown in Fig. 2 and that for calcium sulphate in Fig. 3. In all cases for both sludges the  $V - \theta$  plots were straight lines, showing that the value of  $m$  was 1 for each sludge and that the sludges are of the "incompressible" type. The curves also show that the value of  $m$  is independent of the pressure at which the filtration is performed up to 22 lb. per sq.in. This was the highest pressure obtainable with the apparatus, but it is proposed to make a further study of this point using a different apparatus that will permit the study of pressures up to 150 lb. per sq.in. The value of the



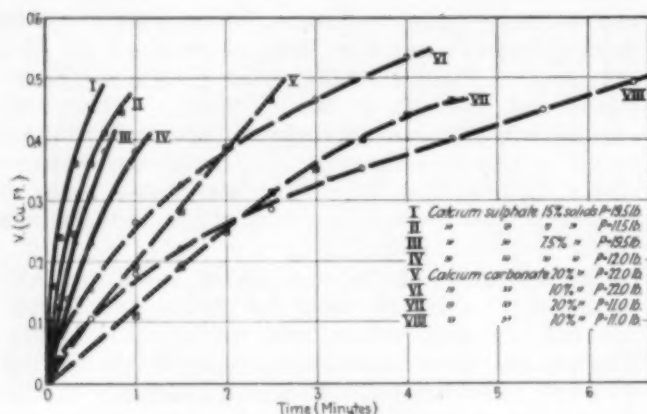
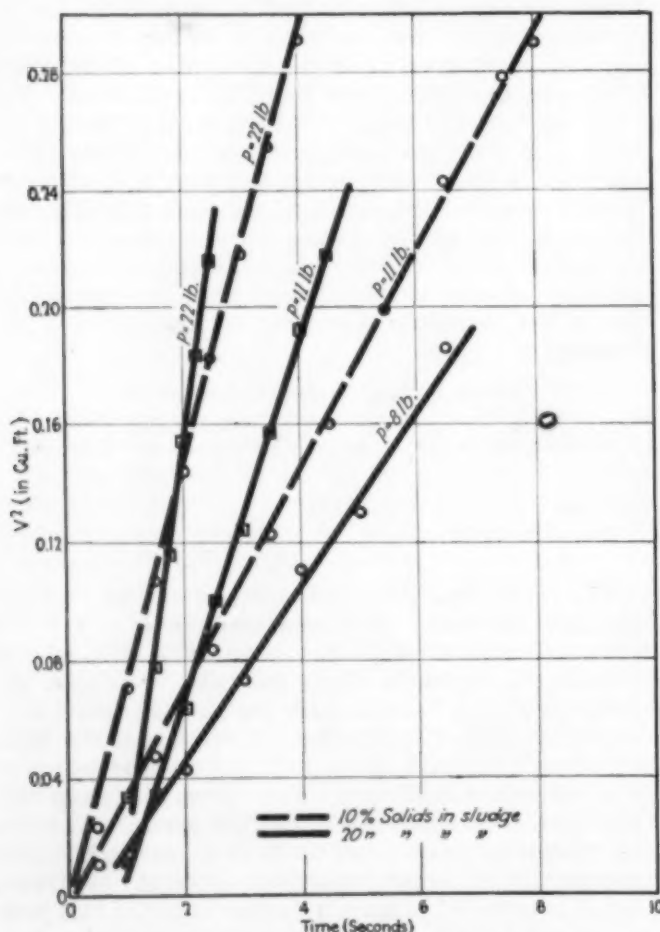
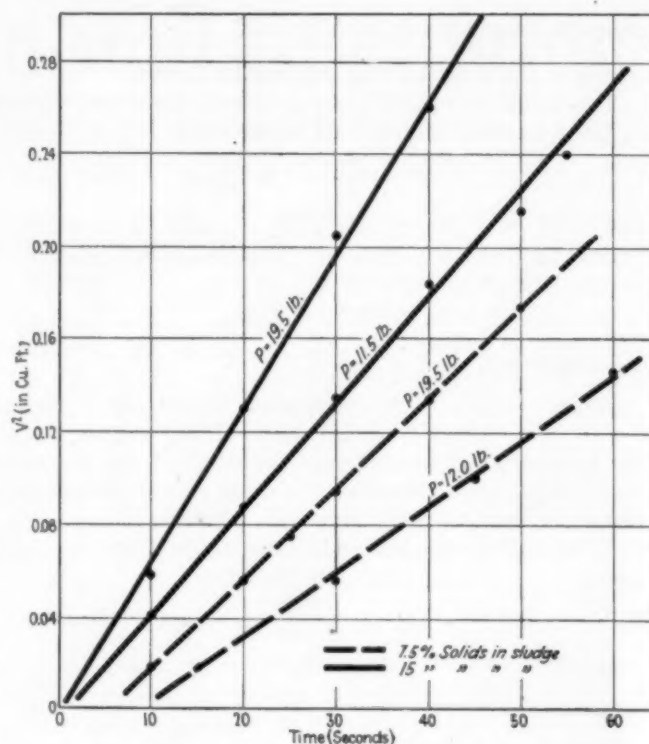


Fig. 1—Constant Pressure Filtration

constant  $m$  was not affected by changing the concentration of solids in the sludge even though the percentage of solids was doubled, as may be seen from the curves. Experiments were also conducted to determine the effect on the constant  $m$  of previously filtering the solids in the sludge and of drying the solids before preparing the test sludge. Neither pre-filtering nor pre-drying the solids produced any effect on the constant  $m$  with either calcium carbonate or calcium sulphate. In all the experiments conducted on either sludge the  $V^2 - \theta$  plots were straight lines showing that the value of the constant  $m$  of the function  $V^m$  was unity for both calcium carbonate and calcium sulphate.

Two methods of calculating the constant  $n$  were also available. A comparison of the two methods showed that the mathematical method of Watermann and Van

Fig. 2—Constant Pressure Filtration of Calcium Carbonate. Determination of Constant  $m$  of Function  $V^m$ Fig. 3—Constant Pressure Filtration of Calcium Sulphate. Determination of Constant  $m$  of Function  $V^m$ 

Gilse was preferable to the graphical solution of Baker both as to accuracy and ease of application. In determining  $n$  by the method of Baker, two errors occurred; one a slight one and the other of considerable magnitude. It was necessary to use the calculated value of  $m$  in calculating  $n$  and therefore a slight error in the calculated value of  $m$  introduced an equal error in  $n$ . The larger source of error in this method, however, was the difficulty of maintaining an absolutely accurate constant rate of flow and reading the exact pressures at the stated intervals. While this is possible theoretically it is extremely difficult practically. Since the curve is a logarithmic one, the errors in plotting were very noticeable; there was only a hint of a straight line passing through the points; and the exact location and slope of the line might vary with different investigators. Baker states that at the start, filtration does not follow the fundamental equation, and therefore he neglects the first few readings. It can easily be shown that neglect of the first readings would give a very different line from that obtained when they are included. This possibility of drawing different curves, having different slopes, each of which apparently gives the correct value for  $n$ , was the greatest source of error.

The errors involved in the calculation of  $n$  according to the other method are smaller. The greatest advantage of this method was that it did not require a filtration at constant rate; the same values used in the determination of  $m$  were used. This not only eliminates the source of greatest error, the constant rate runs, but it also simplifies the experimental work necessary for the determination of the filtration constants.

The values of  $n$  for the various sludges of calcium carbonate and calcium sulphate are summarized in Table II.

The maximum variation from the mean value is 5.75 per cent with calcium carbonate and 6.25 per cent with calcium sulphate. The amount and irregular order of this variation suggests that it is due to experimental

Table II—Values of the Constant  $n$  of the Function  $P^n$ 

Type of Sludge	Calcium Carbonate 10 Per Cent Solids	Calcium Carbonate 20 Per Cent Solids	Calcium Sulphate 7.5 Per Cent Solids	Calcium Sulphate 15 Per Cent Solids
Unfiltered. . . .	0.90	0.83	0.75	0.80
Pre-filtered. . .	0.83	0.92	0.82	0.82
Pre-dried. . . . .	0.89	0.85	0.81	0.81
Average. . . . .	0.87		0.80	

errors magnified by the difference of the logarithms of the observed values. It seems reasonable to conclude that the constant  $n$  is independent of the concentration of solids in the sludge and of their treatment previous to making up the sludge, that is, pre-filtering and pre-drying. Furthermore, it is possible that an average value of 0.85 for the constant  $n$  will hold for all incompressible sludges. This conclusion needs verification, however, by experience with other similar sludges.

The numerical value of the constant  $K$  was determined from the filtration data obtained in the constant pressure runs. From the filtration equations, we can derive a simplified equation for the calculation of  $K$ .

$$R = \frac{dV}{d\theta} = K \frac{A^2 P^n}{V^m}$$

Simplifying:

$$V^m dV = KA^2 P^n d\theta$$

Integrating:

$$\frac{V^{m+1}}{m+1} = KA^2 P^n \theta$$

$$V^{m+1} = (m+1)KA^2 P^n \theta$$

$$K = \frac{V^{m+1}}{(m+1)A^2 P^n \theta}$$

where:

$\theta$  = time in hours

$V$  = volume in cubic feet

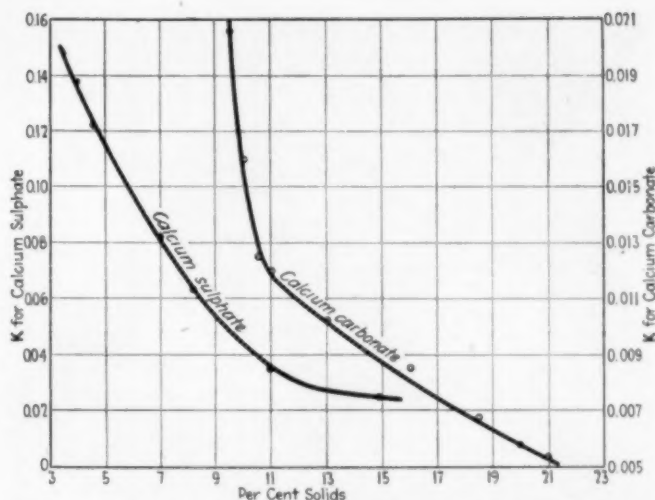
$A$  = filtering area in square feet.

The value of  $K$  includes the variable effects caused by temperature, solid concentration, viscosity and surface tension. Because pre-filtration, and pre-drying showed no effect on the values of  $m$  and  $n$ , it seemed likely that the value of  $K$  would be unaffected. The calculated values of  $K$  for the original, pre-filtered and pre-dried sludges are tabulated according to pressure and solid concentration below:

Table III—Values of the Constant  $K$ 

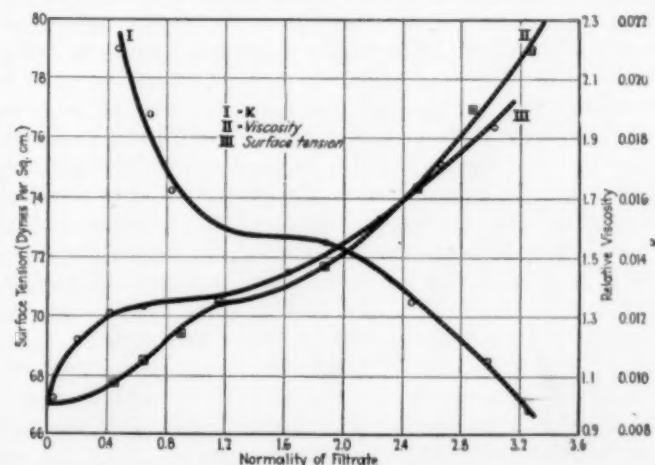
Type of Sludge	Pressure, Lb. Sq. In.	Calcium Carbonate		Calcium Sulphate	
		20 Per Cent Solids	10 Per Cent Solids	15 Per Cent Solids	7.5 Per Cent Solids
Unfiltered. . . . .	19.5 to 22.0	0.00615	0.0210	0.0368	0.0718
	11.0 to 11.5	0.00615	0.0215	0.0356	0.0711
Pre-filtered. . . .	19.5 to 22.0	0.00540	0.0210	0.0261	0.0757
	11.0 to 11.5	0.00530	0.0215	0.0251	0.0800
Pre-dried. . . . .	19.5 to 22.0	0.00550	0.0190	0.0330	0.0777
	11.0 to 11.5	0.00540	0.0195	0.0335	0.0801
Average. . . . .		0.00565	0.0206	0.0317	0.0761
Maximum Variation from mean. . . . .		9 per cent	8 per cent	20 per cent	6.5 per cent

As might be expected, because of the larger number of variables affecting the value of  $K$ , the variation from the mean value is much larger with this constant than with the others. The irregular order of the variations, however, leads to the conclusion that pre-filtering or pre-drying the solids of the sludge have no effect on the value of the constant. This conclusion is substantiated by the fact that, theoretically, if there is no change in the values of  $m$  or  $n$  by such treatment, there can be none in  $K$ . In preparing the sludges it proved to be extremely difficult to obtain exactly identical percentage solid composition. The variation of  $K$  for these different types of sludges when filtered under controlled and nearly identical conditions of temperature, pressure and viscosity can be largely ascribed to this fact.

Fig. 4—Variation of  $K$  with the Proportion of Solids in Sludge

The results of the study of the effect of solid concentration on the value of the constant  $K$  are shown by the curves of Fig. 4. These curves show that this effect is very marked especially at lower concentrations. The curves are hyperbolic, showing a tendency to become asymptotic to the axis at their extremities. This might be explained as follows: As the percentage solids approaches zero, the rate of filtration would become greater, approaching as a limit the rate for pure water, opposed only by the resistance of the press. Conversely, as the percentage solids increases, the rate approaches zero, reaching it at that percentage where water can no longer be squeezed from the cake. The curves show clearly the difference between the two sludges. Calcium carbonate at the lower concentrations filters much more readily; the constant for 10 per cent solids is equal to that of a 4 or 5 per cent sludge of calcium sulphate. On the other hand, the curves indicate that the rate of filtration falls off much more rapidly with increase of solids for calcium carbonate than for calcium sulphate, that is, that the latter would give a "drier" cake.

The effect of variations of the viscosity and surface tension of the filtrate on the value of the constant  $K$  for calcium carbonate is shown by Fig. 5. The ideal method for studying these effects would have been to vary one of the factors while holding the other constant. Unfortunately this was impossible so these conclusions can be drawn only as to the combined effect. It is at once evident from the curves that any increase in

Fig. 5—Variation of Viscosity, Surface Tension and  $K$  of Calcium Carbonate with Alkalinity of Filtrate



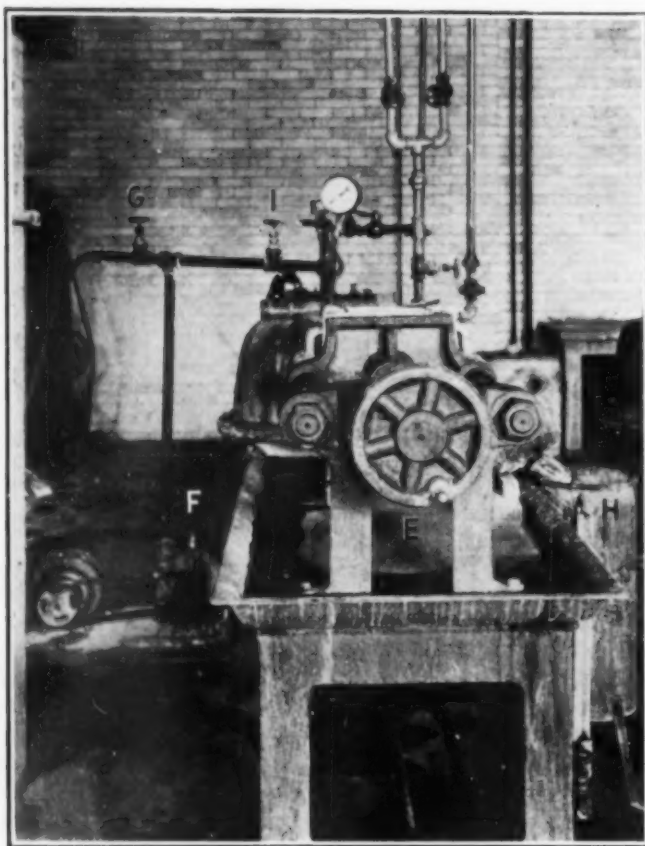


Fig. 6—Plate-and-frame Filter Press and Belt-driven Centrifugal Pump as Arranged for Experiments

viscosity or surface tension of the filtrate produces a decrease in the rate of filtration, that is, in the value of the constant  $K$ . This is exactly what would be expected of surface tension, since there is a tendency to force the filtrate into the pores of the cake. Likewise a consideration of Baker's derivation of Lewis and Almy's filtration formula shows that the constant  $K$  should vary inversely as the viscosity since it represents the expression

$$\frac{K \pi r^4}{8 \mu}$$

of Poiseuille's Law. The effect of increasing the concentration of caustic alkali in the filtrate in decreasing the value of  $K$  is most marked up to a concentration of 1 normal; from 1 normal to 2 normal the effect is very slight; and from 2 normal to higher concentrations, the value of  $K$  decreases again at a more regular rate. These changes parallel the variation of the curves of surface tension and viscosity. Above 2 normal both these properties increase at a regular rate. Between 1 normal and 2 normal both curves show a flattening corresponding to that for the value of  $K$ . No exact explanation of this change in the properties of the filtrate between these normalities can be given but it is possible that it is due to mutual solubility effects between the caustic and the calcium carbonate. The rapid decrease of  $K$  at normalities below 1 normal seems to be due in large measure to the effect of surface tension which increases at a high rate up to about 0.5 normal. The study was not extended much above a concentration of 3 normal because the curves seemed to be proceeding in a regular manner and at higher concentrations experimental difficulties were experienced.

In studying the effect of increased viscosity and surface tension of the filtrate upon the calcium sulphate

sludge, experimental difficulties were encountered which made the results seem unreliable. The alkali in the filtrate seemed to produce a change in the structure of the calcium sulphate cake so that the particles ran through the filter cloth producing a milky filtrate. Up to a concentration of 0.7 normal, the value of  $K$  actually increased slightly with increasing alkalinity of filtrate which was exactly the opposite effect to that predicted and found with the other sludge. This may have been due to the change in the structure of the cake, but the increase was so slight that it was almost within the experimental error of the determination of the values of  $K$ . A further study of this point is necessary before definite conclusions can be drawn.

It was thought unnecessary to make a definite study of the effect of temperature upon the value of  $K$  since this effect is clearly predictable from theoretical considerations. A rise in temperature causes a decrease in both the surface tension and the viscosity of the filtrate and both of these effects would tend to increase the value of  $K$ . Conversely, a decrease in temperature would cause a decrease in the value of  $K$ . It is difficult to see how temperature could have any further effect on the rate of filtration so that it seems safe to conclude that, in general, the value of  $K$  varies directly with the temperature.

#### DESCRIPTION OF APPARATUS

The experimental apparatus comprised a 12-in. plate-and-frame filter press (E), a centrifugal pump (F) belt driven by a  $\frac{1}{2}$ -hp. motor, four wooden tanks (A, B, C, D) each of 75-gal. capacity and fitted with motor-driven agitators (J) revolving at 40 r.p.m. and a receiver (H) of 1 cu.ft. capacity calibrated in 0.01 cu.ft. divisions. The tank containing the sludges to be filtered was connected to the pump by means of 1-in. rubber hose. By opening or closing the bypass valve (G), the pressure of the filtration was regulated. In this manner, close regulation was obtained without moving the position of the supply valve (I). When filtering the 20 per cent sludge, four  $\frac{1}{2}$ -in. frames were used and for the 10 per cent sludge, two  $\frac{1}{2}$ -in. frames were used. The filtering area was 1.356 sq.ft. per plate. The filter cloth used was No. 20 cotton duck. All filtrations were made at a temperature of 20 deg. C.  $\pm$  2 deg.

The calcium carbonate sludge was prepared in the following manner: Fifty-eight pounds of 99 $\frac{1}{2}$  per cent



Fig. 7—Wood Tanks Each 75-gal. Capacity and Fitted with Motor-driven Agitators

lime was slaked and placed in a large wooden tank (A). Enough water was added to make a thin sludge in the tank, and 115 lb. of soda ash (58 per cent) was added in small increments over a period of 3 hr. After the addition of the soda ash, the mixture was agitated 12 hr. and allowed to stand until the calcium carbonate had settled. The sodium hydroxide liquor was then siphoned into another tank (B) and the calcium carbonate was again agitated with sufficient water to fill the tank, for approximately 5 hr., and again allowed to settle. The caustic liquor was again decanted and the combined liquors were concentrated and used later. The addition of water, agitation, settling and decantation were repeated until the wash water showed only the slightest trace of alkalinity. The sludge was then made up so that it contained 20 per cent calcium carbonate by weight.

The calcium sulphate sludge was prepared from the previously used calcium carbonate in the following manner: Fifty pounds of calcium carbonate was placed in one of the 75-gal. tanks, about 60 gal. of water added, and the mixture agitated. During agitation, approximately 55 lb. of commercial sulphuric acid was added at a rate of 0.15 lb. per min. which required about 6 hr. When the precipitation of calcium sulphate was complete, as shown by a laboratory test with methyl orange, the addition of sulphuric acid was discontinued. The sludge was then made up to approximately 15 per cent calcium sulphate by weight.

The pre-filtered sludges were prepared by taking the filter cakes from the experiments run at the highest pressure and mixing them with sufficient water to give a 20 per cent sludge of calcium carbonate and a 15 per cent sludge of calcium sulphate. For the pre-dried sludges, the cakes from previous filtrations were dried at 160 to 170 deg. F. for 8 hr., cooled, weighed and mixed in one of the wooden tanks with the calculated amount of water to make the concentrated sludges as before. For the study of sludges with varying concentrations of solids these concentrated sludges were simply diluted with the calculated amount of water. The solid concentration of all sludges was determined by filtering and drying a weighed sample in the laboratory.

#### CONSTANT PRESSURE EXPERIMENTS

The sludge was thoroughly agitated before filtration was started. The bypass valve (G) was then closed and the valve (I) which controlled the supply of sludge to the press was opened. As soon as the first drop of filtrate was received in the calibrated receiver, the time was noted. At intervals of 0.5 min. with the calcium carbonate and from 5 to 15 sec. with the calcium sulphate, the volume was noted and recorded. The pressure of the run was kept constant by operating the bypass valve (G). When the press was full, the supply valve was closed and the bypass valve opened.

#### CONSTANT RATE EXPERIMENTS

The constant rate filtrations used to test Baker's method of calculating the constant  $n$  were performed in the following manner: The bypass (G) was left open and the supply valve opened suddenly. At the time the first drop of filtrate reached the receiver, the time was noted and at the end of 0.5 min. the volume of filtrate was read. The pressure necessary to maintain this rate of flow constant was obtained by slowly closing the bypass valve. At half-minute intervals, the volume and pressure were recorded. It was extremely

difficult to maintain an absolutely accurate constant rate of flow and obtain the exact pressures at the stated intervals.

#### EFFECT OF VISCOSITY AND SURFACE TENSION

For this series of experiments a 10 per cent sludge of calcium carbonate was prepared. Eight experiments were made with variation of the viscosity in the following manner: The first one was made on the freshly prepared sludge, to which no foreign substance had been added to increase the viscosity. The filtrate thus had the viscosity and surface tension of a saturated solution of calcium carbonate. After completion of the first experiment a portion of the concentrated sodium hydroxide solution obtained in preparing the original sludge was added, the mixture was agitated and another filtration was performed. Still more caustic was then added and the procedure repeated. In this way, the conditions of the sludge were kept constant with the exception of the viscosity and surface tension. Samples of the filtrate were taken after each filtration and their relative viscosity and surface tension determined.

### Competition in Lime Markets

Foreign competition in the domestic lime market has in the past been relatively insignificant but with the increased interest which is manifest in adjacent countries such as Canada and the South American States, increased competition from these sources can be expected. This condition will also be augmented by the rapid developments which are being made in shipping containers with the resultant increased safety of water transportation. In Table IV is tabulated the Bureau of Mines data on Lime imported for consumption in the United States for the years 1915 to 1924.

Table IV—Lime Imported for Consumption in United States, 1915-1924\*

Year	Short Tons	Value		Year	Short Tons	Value	
		Total	Average			Total	Average
1915.....	1,956	\$22,489	\$11.50	1920.....	22,688	\$392,137	\$17.28
1916.....	7,959	71,663	9.00	1921.....	10,811	234,798	21.72
1917.....	7,353	70,505	9.59	1922.....	14,112	290,845	20.61
1918.....	6,650	73,458	11.05	1923.....	25,407	428,903	16.88
1919.....	8,679	128,519	14.81	1924.....	20,480	377,994	18.46

\* Most of the lime imported into the United States comes from Canada.

Lime exportation reached a maximum during the war period and slumped to an insignificant figure during the industrial depression following the war. The curve, however, is now rising rapidly and wonderful possibilities are apparently in the offing for a lime exporting business. The demand for better and different types of construction and the growth of the chemical industries in adjacent territories, and the appreciation by the foreigner of the progress which has been made in lime production and service in this country will unquestionably accelerate the increase of exports.

Except in Canada practically no competition from foreign manufacturers is found in these foreign fields and the possibilities appear to be of considerable importance. A tabulation of exports is shown in Table V.

Table V—Lime Exported from the United States, 1915-1924

Year	Short Tons	Value		Year	Short Tons	Value	
		Total	Average			Total	Average
1915.....	16,223	\$106,312	\$6.55	1920.....	5,921	\$128,296	\$21.67
1916.....	23,973	132,769	5.54	1921.....	5,192	109,769	21.14
1917.....	18,794	168,671	8.97	1922.....	8,289	116,649	14.07
1918.....	7,191	105,803	14.71	1923.....	11,789	170,289	14.44
1919.....	6,372	108,370	17.01	1924.....	14,905	212,340	14.25

Concluded from the article by Gordon Willis, pp. 752-754, December, 1926, entitled, "Marketing Lime, the Chemical Base for Many Industries."



# Absorption of Nitrogen Oxides from Ammonia Oxidation

How the patented Toniolo-Nitrum process is being applied in the synthetic nitric-acid industry in Europe

By Carlo Toniolo

Consulting Director, Soc. Anon. Azogeno; Soc. Anon. per la Fabbricazione dell'Ammoniaca Sintetica e Prodotti Derivati, Milan, Italy

THE MAGNITUDE of the synthetic nitric-acid industry is illustrated by the growth from 1913 to 1920 in total annual capacity of plants, from 100,000 tons to 150,000 tons for direct oxidation (arc) processes, and from nothing to 745,000 tons for the oxidation of ammonia. In both methods there are two principal stages of production, namely oxidation and absorption. This discussion will be confined to absorption.

The NO content of gases from the arc process ranges from 1.1 to 2.5 per cent; in gases from oxidized ammonia the range is 7 to 10 per cent. Early plants for oxidizing ammonia were patterned after the successful Scandinavian plants in the construction of absorption towers, with no heed to the fact that the difference in NO concentration was important. Even the fact that the best of the Scandinavian absorption towers were not strictly modern was disregarded. As a result the monstrous towers which were built (10 to 25 meters high and 4 to 6 meters in diameter) were costly and inefficient. Only in the last few years has the process been established on a sound technical basis. The extent and character of the progress which has been made may be seen from the curves and figures shown in Fig. 1.

This paper is based on a study of the French plant at Angoulême. Certain facts were noted which have already been published by Pascal ("Syntheses et Catalyses Industrielles" 1925); among these was the decomposition, in the first towers, of acid already formed, and the relatively high final temperatures (often 40-60 deg. C.) due to the heat of the reaction which occurs in them.

There is need for a study of the chemical and physico-chemical processes taking place in the towers; such studies were necessarily neglected in the rush of production during the war period. Among the factors which should be investigated are: (1) The conditions under which  $\text{HNO}_3$  dissociates; (2) effect of temperature on the reaction rates of nitrogen oxides; (3) confining oxidation to the "oxidation" towers as against the "absorption" towers proper; and (4) influence of the dimensions and distribution of filling materials in the towers. The literature already contains accounts of investigations on most of these points, which certainly were not available to the builders of war-time plants in Europe and America.

1. (a). If the acid from one tower is weaker than that in the preceding tower, it is not correct to assume that it was impoverished by distillation of  $\text{HNO}_3$  from its aqueous solution in the first tower. At concentra-

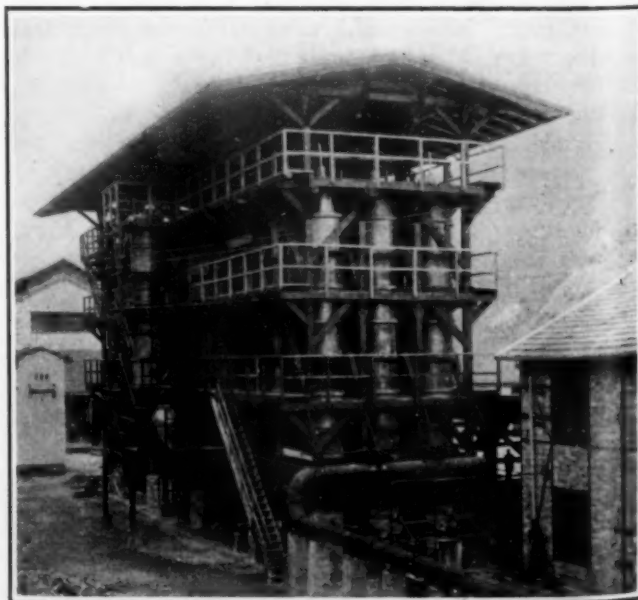
tions from 45 to 55 per cent the boiling point is still higher than the prevailing temperature of 40 to 60 deg., even considering that the partial pressure of  $\text{HNO}_3$  vapor is less than 760 mm. and that the vapors are diluted by large quantities of inert gas. Hence, at 45 to 55 per cent the evaporation rate should be greater for  $\text{H}_2\text{O}$  than for  $\text{HNO}_3$ , and the solution coming from the tower should be richer, not poorer in acid.

(b). Moreover, at the temperature observed in the tower there is a true thermal dissociation.

(c). Besides, theory predicts a decomposition of  $\text{HNO}_3$  due to reduction by NO. According to Saposhnikov (*J. Russ. Phys. Chem. Soc.*, vol. 32, p. 375, 1901) the rate of this reduction is 25 times faster in 65 per cent acid than in 10 per cent acid. It is true that NO can exist in solution in  $\text{HNO}_3$ , and that its presence is not in itself sufficient for reduction; but  $\text{N}_2\text{O}_4$  decomposes more readily at high temperature, and there is no doubt that the nascent NO thus formed would act on the  $\text{HNO}_3$ . Marchlewski (*Zeitschrift für anorganische Chemie* No. (5), vol. 88, 1924) has shown that such a mutual decomposition of  $\text{N}_2\text{O}_4$  and  $\text{HNO}_3$  does occur in warm concentrated acid.

*Conclusion I:* Cooling of the tower is advisable for retarding the decomposition of concentrated  $\text{HNO}_3$  by thermal and chemical action.

2. Nitrous oxide may react with NO, forming  $\text{N}_2\text{O}_3$ ; or it may polymerize to  $\text{N}_2\text{O}_4$ . The degree of this aggregation depends on temperature and partial pressures.



Absorption Towers at Synthetic Nitric Acid Plant at Bussil, Italy





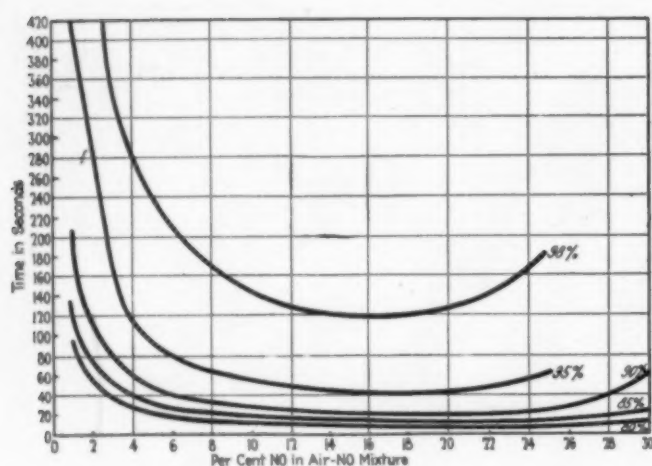


Fig. 2—Curves Showing Time Required for Oxidizing NO to Various Limits (98, 95, 90 and 80 per cent) at 20 to 30 deg. C.

*chimie*, vol. 34, p. 183, 1918). Bodenstein's curves when extrapolated to  $-20$  deg., show that at  $50$  deg. to  $60$  deg.,  $K$  is 2 to 3 times smaller than at  $-10$  deg. to  $-20$  deg.

The importance of this is emphasized in Fig. 4, drawn from data of Lunge and of Bodenstein, which shows that a 98 per cent oxidation of  $\text{NH}_3$  takes 240 to 250 minutes at  $45$  deg. to  $60$  deg. (as at Angoulême), 180 to 190 minutes at  $25$  deg. to  $30$  deg. (presumably German plant conditions), and only 110 minutes below  $0$  deg.

#### EFFECT OF LOWER TEMPERATURES

As shown in the equations above, the  $\text{N}_2\text{O}_5$  reaction regenerates two-thirds, and the  $\text{NO}$  reaction only one-third of the  $\text{NO}$ . With each repetition the  $\text{NO}$  content diminishes, so that the inert gases become constantly poorer in  $\text{NO}$  and the time required for its reoxidation increases. Since the total oxidation time factor can be cut in half, a corresponding speeding up of other steps would make it possible to reduce by half the size of a plant of the Angoulême type by operating at sub-zero temperatures. In view of the magnitude of the industry the industrial importance of such an improvement may be readily seen. Low temperature operation is feasible, because nitric-acid solutions have lower freezing points than water.

*Conclusion III:* Cooling would be very effective in speeding up the oxidation of  $\text{NO}$ .

3. In French plants the towers were made not so much for complete or nearly complete oxidation to  $\text{NO}_2$ , as for the reaction with water. In Germany the towers at the Hoechst plant were not fitted for oxidation, but at Oppau they were. In American plants the towers have ample space which may serve as alternate chambers for oxidation and absorption.

The authorities already cited (Raschig, Lunge, Sansfourche, Wourtsel, Bodenstein, etc.) do not agree among themselves as to the relative importance of the functions of  $\text{N}_2\text{O}_5$  and  $\text{N}_2\text{O}$  in nitric-acid synthesis. This is not surprising, since  $\text{N}_2\text{O}$  has the advantage of regenerating only one-third of the  $\text{NO}$  whereas  $\text{N}_2\text{O}_5$  has the

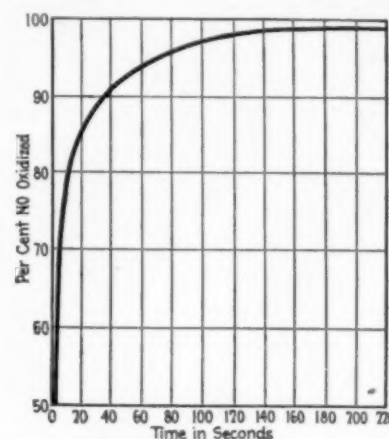
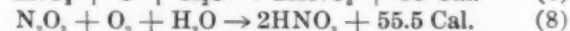
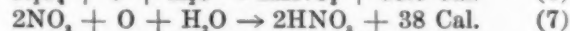


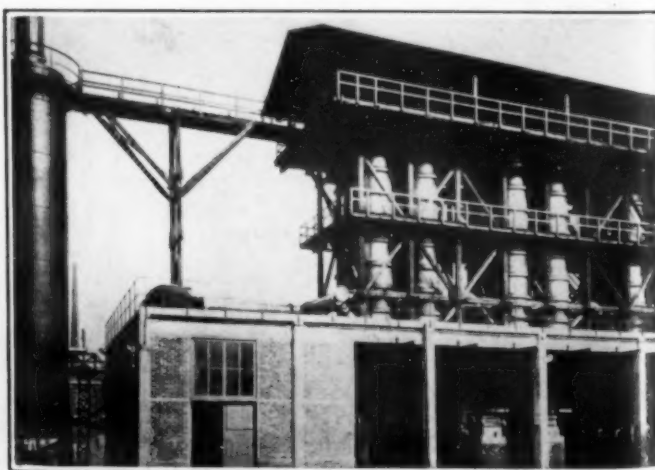
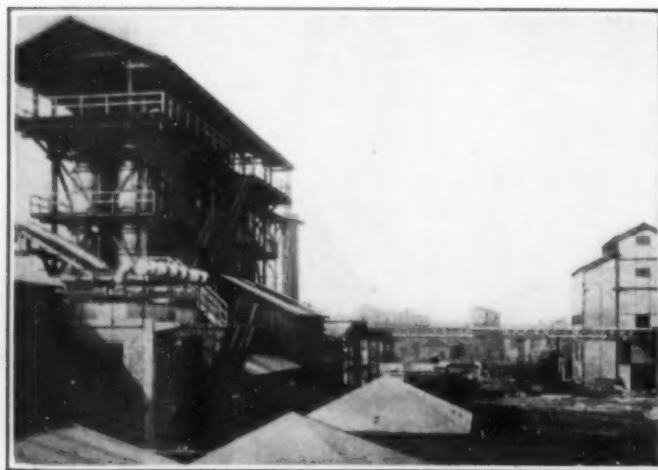
Fig. 3—Rate of Oxidation of  $\text{NO}$  to  $\text{NO}_2$  at about  $25$  deg. C.; Initial concentration of  $\text{NO} = 8.5$  per cent

advantage of a much more rapid rate of formation from  $\text{NO}$ .

But the reasoning of Conclusions I and II shows clearly that the absorption should not be started until all or practically all of the  $\text{NO}$  is oxidized to  $\text{NO}_2$ . Indeed, the thermochemical nature of the process is itself sufficient to prove this:



Considering that it takes about 5 cu.m. of gas (specific heat about 0.3) to yield 1 kg. of  $\text{HNO}_3$ , corresponding to about 1.8 kg. of the aqueous acid (the average specific heat throughout the process is about 1.33), the temperature rise during absorption would be, on the average, about  $53$  deg. for  $\text{N}_2\text{O}_5$ , about  $78$  deg.



Two Views of Absorption Towers in the Kuhlmann Plant at Lille, France

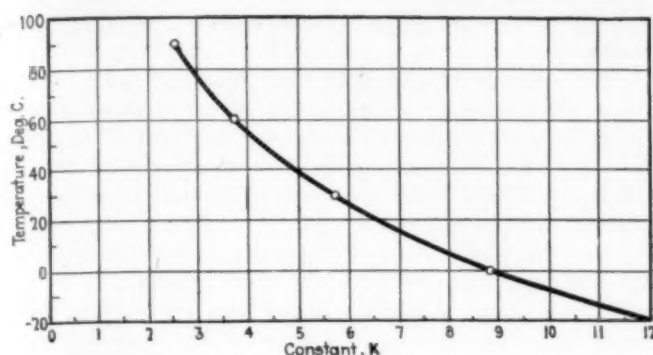


Fig. 4—Illustrating the Negative Temperature Coefficient of  $K$  for the Reaction:  $2 \text{NO} + \text{O}_2 = 2 \text{NO}_2$

for  $2\text{NO}_2$  and about 114 deg. for  $\text{N}_2\text{O}_5$ . The much greater temperature rise in the third case is prejudicial to the conditions of the process.

Moreover, the two cases set forth in *IIa* show that  $\text{NO}_2$  or  $\text{N}_2\text{O}_5$  in the first reaction with water, gives twice as much acid as  $\text{N}_2\text{O}_3$ . This is another factor for greater plant efficiency.

#### CONDITIONS FOR EFFICIENT OPERATION

**Conclusion IV:** For efficient operation, the oxidation of  $\text{N}$  should be effected to the maximum extent, and the heat evolved should be removed by cooling *before* starting the absorption in  $\text{H}_2\text{O}$ .

Of course the temperature rises cited above would not be reached in actual practice; dissipation of heat to the outside, and expenditure of heat in evaporating and dissociating the acid and depolymerizing  $\text{N}_2\text{O}_4$  would tend to keep the temperature down. At the same time the oxidation of  $\text{NO}$  would be slowing down, retarding the exothermic reactions of the process.

These effects are well illustrated in the curves of Fig. 1, in which the Angouleme acid formation curve is most nearly horizontal. In the German plant there is at least a partial cooling of the acid in water-cooled coils, and the curve rises more rapidly. Finally, in the case of vigorous cooling, the curve rises sharply; there is practically no retarding of acid formation.

It is all the more necessary to eliminate every possible retarding factor in the first towers, in view of the fact that even in these the absorption of the acid formed can take place only at the expense of a certain amount of slowing down due to the high concentration of the acid circulating in the towers.

These considerations hold, not only for gases from the oxidation of  $\text{NH}_3$ , but also for the more dilute gases of the arc process. Indeed, the Societe Nitrum of Zurich has a plant on the Rhine, with a daily production capacity of 20 tons of 100 per cent acid, which has been in regular operation along these lines for several years. The Norway towers operate without any cooling; the acid is then circulated through absorption towers which are cooled below 0 deg. The results give an excellent confirmation of what has been said above.

#### PREVENTING CHANNELS OR VEINS

4. (a). In towers of large diameter (4 to 6 m.), in which the gases and liquids circulate on the counter current principle, there is much less actual contact than is generally believed. There is a tendency to the formation of parallel veins of motion rather than thorough mingling. This vein formation was observed by Pascal

at various points in the cross section of large towers, in his investigations at Angouleme.

(b). Another serious mistake, at Angouleme and in other plants, is that of filling the towers with rings or perforated balls or like symmetrical fillers, instead of irregular shaped materials, which would prevent regular motion of the gases and liquids in channels or veins. This has been confirmed in Italy and at Angouleme, by an efficiency comparison between Scandinavian towers with irregular filler and the French plant, at the time when the latter was beginning to operate with dilute gas (1.25 to 1.5 per cent oxides of  $\text{N}$ ). The rate of absorption per cu.m. of plant capacity could easily be doubled (or even more) by due attention to the considerations just set forth (see also Pascal, loc. cit., p. 170 and p. 194).

#### TOWERS OF SMALL DIAMETER

**Conclusion V:** A factor of utmost importance for the efficiency of an absorption plant is thorough contact, which should be promoted by making the diameter of the towers as small as possible, and filling in such a way as to compel the gases and liquids to traverse irregular and constantly changing paths.

In collaboration with the Societe Nitrum of Zurich, plants on the principles discussed in this paper have

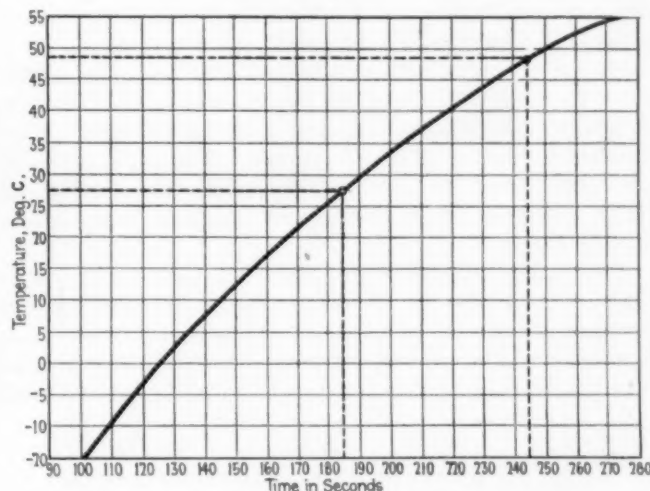


Fig. 5—Effect of Temperature on Rate of Oxidation of  $\text{NO}$ , 8 per cent, from Ammonia Oxidized in Air. Final Limit of Oxidation, 98 per cent

been or are being built at Bussi (for the Societe Azogeno), at Ougree in Belgium, near Lille, at Cirey, and at two points in Spain. The great importance of scientific research in industry is illustrated by the fact that the investment in nitric acid from ammonia probably amounts to more than \$10,000,000 and is constantly increasing.

#### Correction

In the article "Solving Some Unusual Problems in Sand Filtration," vol. 33, p. 532, the formula given as

$$T = (.26 \times 7) \frac{l}{0.448} = (.26 \times 7)^{2.33} = 3.8 \text{ hours}$$

should read

$$T = (.26 \times 7) \frac{1}{0.448} = (.26 \times 7)^{2.33} = 3.8 \text{ hours}$$

in addition to the corrections given on page 694 of vol. 33, No. 11.



## A Forward Step in Manufacture of Arsenic Acid

Difficulties caused by foaming of nitric acid-arsenic mixture prevented by recent modification of present practice

By E. A. Suverkrop

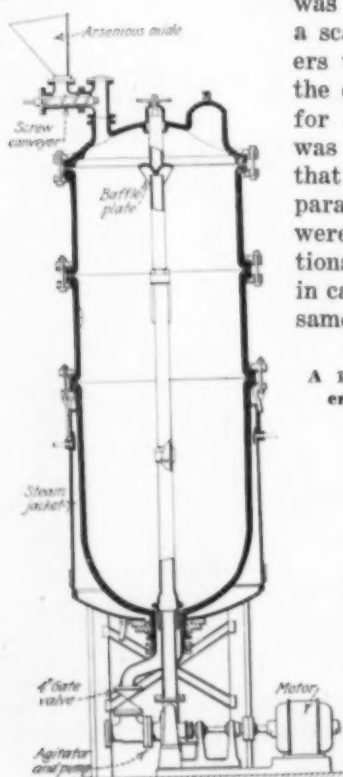
Chemical Engineer, The Durlin Co. Inc., Dayton, Ohio

**T**HE FIRST chemical engineering advance in producing arsenic acid on a large scale and in reducing labor cost and nitric-acid loss was taken in the plant built in 1919-1920 in Bound Brook, N. J. This work was done for Hemingway & Co., under the direction of Howard W. Ambruster, and with the active co-operation of the writer.

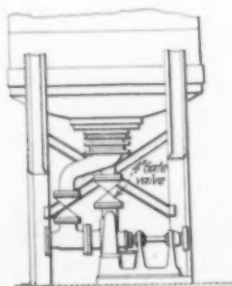
For the first time this plant utilized large ferro-silicon steam-jacketed kettles with slow-moving agitators and bottom discharge for the finished product. A mechanical feed with variable speed control was the next step taken at this plant and batches of over a ton of arsenic were converted into nearly three tons of 75-per cent arsenic acid in from eight to ten hours with the recovery of about 95 per cent of the nitric acid utilized in the reaction. This plant was a great improvement over the previous methods which utilized small stoneware pots, fed intermittently by hand, stirred, if at all, by a stick or by blowing compressed air into the batch through a glass tube. The pots were heated with live steam or steam coils and the batch discharged when finished by means of an air siphon. The advantages of the larger and stronger kettles with easy control of temperature and slow, continuous agitation were immediately apparent.

The more uniform reaction resulted in a nitric-acid recovery consistently higher than had been considered possible in the old days and the larger batches were handled quickly. Tonnage production of arsenic acid

was thus made possible on a scale that enabled producers to meet the increase in the demand for arsenic acid for calcium arsenate which was developing rapidly at that time. Within a comparatively short time there were ten similar installations at other plants varying in capacity but following the same general system, which



A 1,000-gal. Arsenic Acid Generator Showing Means for Outside Agitation and Overcoming Foaming Difficulties



has since been accepted as standard by the insecticide industry.

Changes and modifications of this first design have been going on ever since, mainly in the type of stirrer utilized to give a more violent agitation in an attempt to cut down foaming, and also improvements in the automatic feed for the arsenic and the bottom outlet for dumping the batch.

However, the one great difficulty of the foaming of the hot batch has persisted in spite of changes in apparatus design. Attempts to increase the rate of feed, beyond a certain point, of arsenic of the highest grade always brought trouble and danger to the operators, and these difficulties were accentuated in a marked degree when off-grade arsenic (below 99 per cent  $As_2O_3$ ) was used. It is the writer's opinion that the foaming difficulty has been overcome, however, in the novel method and equipment described by Ambruster in his U. S. Patent 1,603,308 issued October 19, 1926.

It is evident to anyone who has witnessed the difference in the foam produced in the reaction between pure arsenic and nitric acid as compared with the foam resulting from the use of off-grade arsenic, that the quantity as well as the quality of the impurities in the arsenic are mainly, if not altogether, responsible for the foam. The foam consists of bubbles containing nitrous gases rising above the surface of the batch and frequently issuing through the feed and peep holes in the lid of the kettle. This same foam results even with 99 per cent arsenic if it is fed too rapidly into the process.

The inventor prevents bubbles or foam from forming by causing the bulk of the reaction to take place outside of the main batch kettle and within the pump or agitator below, and then by releasing the gas from a fountain discharge above the level of the surface of the batch in the main kettle, the foam is continuously broken and the gas is liberated in the open space above the batch. From here it is then drawn immediately into the suction pipe leading to the cooling system or condenser and then on to the hyponitric absorption towers.

It now seems evident, once it has been pointed out, that the usual heavy layer of bubbles stabilized by suspended particles cannot form in the batch when the bulk of gas is liberated in the pump chamber and escapes before it gets back beneath the surface of the batch.

Modification in design of the kettles previously utilized for arsenic acid has been made along with a complete assembly of other equipment for the carrying out of the method covered by this patent. Such a kettle is shown in the accompanying illustration. It permits of a very decided speeding up of the time required to put through a batch of 99 per cent arsenic and should also permit of the utilization with economy of an off-grade of arsenic running much lower than 99 per cent. The saving through the use of such arsenic should also be considerable although not so great now that arsenic is selling at a low price, as during those periods when it shoots up to 10 or 15 cents per pound. In any case, however, the increased capacity per unit is desirable as it saves capital investment and labor cost. Nowhere is flexibility of capacity more important than in an arsenic acid plant, the output of which is required for an insect poison market which is frequently sluggish or non-existent for eleven months of the year and then suddenly calls for an enormous tonnage, as was the case in August of last year.

# Dehydration of Manufactured Gas

Several methods that might be used with their advantages and disadvantages. The economy of the process

By F. W. Sperr, Jr.

Director of Research, The Koppers Co., Pittsburgh, Pa.

IN MOST manufactured gas systems, the gas as it enters the distribution mains is saturated with water vapor. More or less of this moisture usually condenses in the mains and means must be provided for its removal. One million cubic feet of gas at atmospheric pressure and 60 deg. F., and saturated at 85 deg. F., carries one ton of water. More than half of this may be deposited in the distribution system.

The disadvantages of this condensation have long been recognized. Expense for the installation and maintenance of drips, interruption of service and replacement of corroded parts is caused by this moisture in the gas. So far, however, there has been little effort on the part of the gas industry to produce dry gas instead of saturated gas. In some cases, partial dehydration has incidentally been accomplished through compression and the results obtained in such cases have furnished interesting proof of the benefits that may be expected from the distribution of dry gas.

A number of recent developments, having quite different objectives, have made the serious consideration of the dehydration of manufactured gas more propitious than has been the case in the past. The development of satisfactory dry meters makes the wet displacement meter no longer a necessity for the measurement of gas at the works. The waterless gas holder and the high pressure storage holder have solved the problem of storing dry gas. Lower heating value standards lessen the necessity for installing drips to take care of oil condensates, while the absence of such oil condensates tends to increase the corrosion caused by the presence of moisture. The substitution of manufactured gas for natural gas is taking place in many cities and natural gas distribution systems are dry systems, so there will be a strong incentive to dehydrate the manufactured gas so that drips will not have to be installed in the distribution mains.

## ADVANTAGES DUE TO DEHYDRATION

In the report of the life of meters committee of the British Institution of Gas Engineers for the year 1919, reference was made to the "Helps System" in which at least partial dehydration was accomplished. This was done simply by compression and cooling. The report cites the experience of one plant in which the gas was compressed to 50 lb. per sq.in., cooled, and subsequently expanded into the mains at 5 lb. per sq.in. No corrosion or naphthalene deposition has been experienced. The condensed water also removes from the gas certain salts which play a direct part in corrosion. The amount of condensation was equivalent to about 80 gal. per million cu.ft. of gas compressed.

The experience of the American Light and Traction Co. was described by D. A. Powell at the recent con-

ference of the distribution committee of the American Gas Association. At one of the properties of this company the gas is dehydrated by compression to 80 lb. pressure and is distributed at about 5 lb. pressure. This system, which has been in operation for 9 years without drips or grades, shows unusual freedom from corrosion and other moisture troubles.

It is unnecessary to remove the last traces of moisture from the gas. The dehydration should be only sufficient to prevent the deposition of liquid moisture anywhere in the system. In most localities in the United States, dehydration to a dew point of 30 deg. F. would be satisfactory and in some places a dew point of 38 to 40 deg. F. would be satisfactory.

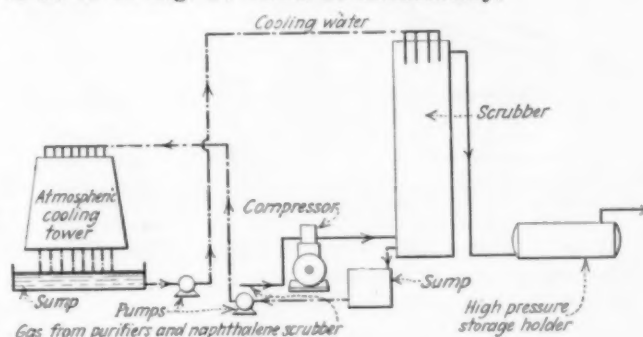


Fig. 1—Flow Sheet for a Compression and Cooling System for the Dehydration of Gas

This flow sheet is diagrammatic and reduces the system to its simplest form

It has been said that "dry corrosion" might be produced through the deposition of small amounts of moisture from gas that is unsaturated, but near its saturation point. In the writer's opinion, if the dew point is maintained at 30 deg. F., or less, the possibility of this dry corrosion need cause no serious concern, especially if the system be kept lubricated by injecting a condensible oil in the form of a fog or vapor.

Moisture may be removed from gas by compression, refrigeration, treatment with hygroscopic substances or treatment with adsorbents. The compression, or rather, compression and cooling method has already been mentioned. In this method, the gas must pass into the distribution system at a much lower pressure than that at which the gas is cooled, so that it may be below its saturation point under every condition. High pressure gas saturated with water vapor offers disadvantages similar to those pertaining to low pressure saturated gas, and these are even intensified owing to the greater concentration of corrosive impurities.

The flow sheet for a compression and cooling system is shown in Fig. 1. The compression to produce the necessary dehydration depends upon the final dew point and pressure required for the gas entering the distribution system and upon the temperature of the cooling water available. Assuming a final dew point of 30 deg.



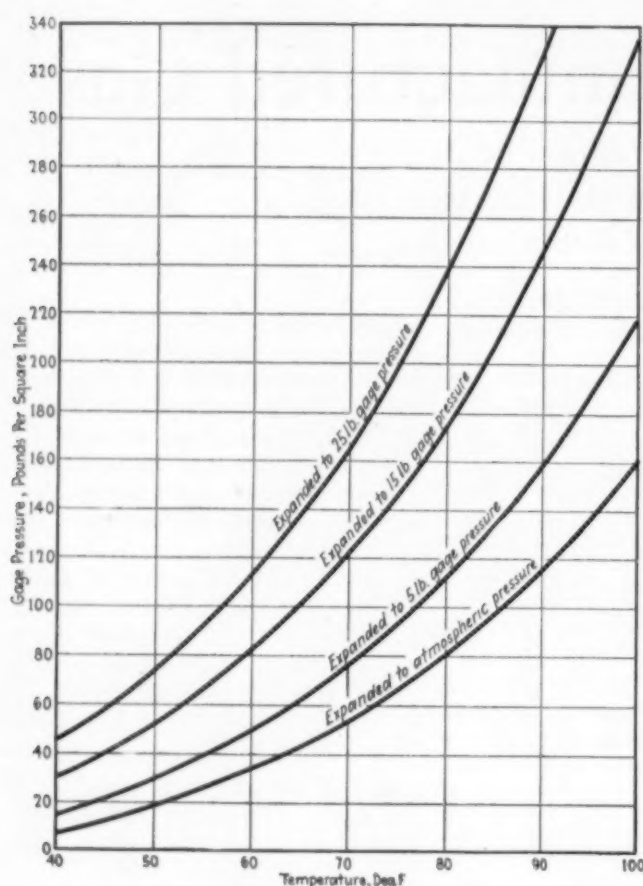


Fig. 2—Pressure Curves for Dehydration by Compression  
Assuming a final dew point of 30 deg. F., these curves show the pressure required at different temperatures and final pressures.

F., Fig. 2 shows the pressure required at different temperatures and final pressures.

Within ordinary limits, the power required by this method depends upon the temperature of the cooling water available and is nearly independent of the final pressure to which the gas is expanded after cooling. Fig. 3 shows the theoretical power required at different temperatures for dehydration to a dew point of 30 deg. F. The curve is based on isothermal compression and thus represents the theoretical minimum power in each case.

Under most conditions, the method is an expensive one on account of high power cost. The advantages are principally those of simplicity and convenience. In practice, the maximum economy would be gained by multi-stage compression with intermediate cooling between stages, but this would have to be balanced against the possibly increased cost of equipment. There is a further possibility of economy in utilizing the cooling effect obtained when the compressed gas is expanded, or in utilizing such expansion as a source of power.

In addition to removing light oil, the compression method would also remove naphthalene and this substance would go out with the cooling water from which it could be separated by means similar to those employed in the final cooler systems of byproduct coke plants. With gases producing little light oil the method, therefore, might serve the two-fold purpose of dehydration and naphthalene removal. Where much light oil is formed, the efficient separation of this would be difficult and it would appear best to use a scrubber, operated to remove sufficient light oil so that no condensation would be produced in the dehydration system. This would permit the efficient recovery of both light oil and

naphthalene and would simplify the cooling water circulation system in the dehydration plant.

#### DEHYDRATION BY REFRIGERATION

The drying of air by refrigeration is practiced in the art of air conditioning. In most such cases a dew point of 40 deg. F. or higher is satisfactory. This is attained by treating the air with sprays of water cooled in refrigerating apparatus. Water can be so cooled to 34 deg. F. which permits dehydration in a single stage apparatus to a dew point of 38 or 40 deg. F.

There is a close analogy between such drying of air and the problem of dehydrating manufactured gas by refrigeration. The following deductions are applicable:

1. The simple, single stage system strongly advocated by Johnson wherein the air is passed over coils in which the refrigerant, ammonia, is caused to expand, does not appear to have found favor in the drying of air, but is worthy of investigation, particularly in connection with small gas works.

2. The most efficient means developed in air conditioning consists in using water or brine as the cooling medium. The water or brine would be cooled in a refrigerating machine and then brought directly into contact with the gas in a scrubber. The gas would first be cooled as much as possible by standard methods. The brine or water leaving the scrubber would then flow back to the refrigerating plant.

3. There are objections to the use of brine in such a system. Means would have to be provided for evaporating the condensed moisture and then recooling the brine. It is said to be more difficult to avoid the entrainment of minute droplets of brine in outgoing air from such a system and such entrainment would be a serious matter in a gas system.

4. Using water as a cooling medium, single stage cooling to a dew point of 38 to 40 deg. F. can be accomplished. This might suffice for warm climates.

5. For reduction to a dew point of 30 deg. F. the present state of the art would appear to offer three alternatives: (a) A two stage system first cooling to 38 or 40 deg. F. by direct contact water and then to 30 deg. F. in a chamber filled with brine-cooled coils. (b) A two-stage system similar to (2) but using refrigerated brine for direct scrubbing in the second stage. (c) A combination system in which gas would be compressed and cooled to 38 or 40 deg. F. by direct contact with refrigerated water so that the cooled, compressed gas when released to the final distribution pressure would have a dew point of 30 deg. F.

6. A system of heat exchange in which the cooled gas would be used to precool the warm gas entering the system is believed to offer no advantages because of the small temperature differences available.

The principal item of expense by cooling by refrigeration is the power requirement. The curves in Fig. 4 show the power requirements for cooling gas from different initial temperatures to final temperatures of 40 and 30 deg. F., respectively, not including power for circulation. The power required for circulation may be taken as about 0.01 hp. per M. cu.ft. of gas per hour.

The power required for dehydration in a compression system may be greatly reduced by supplemental refrigeration, using water cooled by refrigeration to 34 or 35 deg. F. With such water, compressed gas could be readily cooled to 40 deg. F. At this temperature the pressure required to produce a dew point of 30 deg. F. in gas released to atmospheric pressure is only 7.7 lb.

In the dehydration of coal gas by refrigeration the loss of heating value due to deposition of light oil would be expected to be much less than in dehydration by compression. Tests showed no appreciable reduction of heating value at temperatures over 5 deg. F. Below this temperature, the heating value diminishes quite rapidly.

#### DEHYDRATION BY TREATMENT WITH HYGROSCOPIC SUBSTANCES

Of the several hygroscopic substances commonly employed the caustic alkalis cannot be used with gas on account of their action upon carbon dioxide. Because of cost other substances are eliminated and there remain but two feasible materials—calcium chloride and sulphuric acid.

Drying gas by means of these desiccators would have the advantage of dispensing with any great amount of compression or artificial cooling, so that removal of light oils would be reduced to a minimum. The utmost precautions would have to be taken to prevent entrainment of the dessicator. The absorption of water by these reagents is an exothermic process liberating relatively large amounts of heat and special cooling means must be provided to prevent the temperature of the system from rising to such a point that dehydration is no longer effective. Means must also be provided to reconcentrate the diluted reagent or else to dispose of it in some way that will not involve too great expense for new material.

Calcium chloride in solid form was used as early as 1880 in the Fryer process. Most processes proposed have used this material in solid form. Although such a process offers possibilities, it suffers the disadvantages that attend large scale treatment of a gas with a solid reagent. If regeneration is conducted in situ, precautions must be taken to prevent liquefaction of the

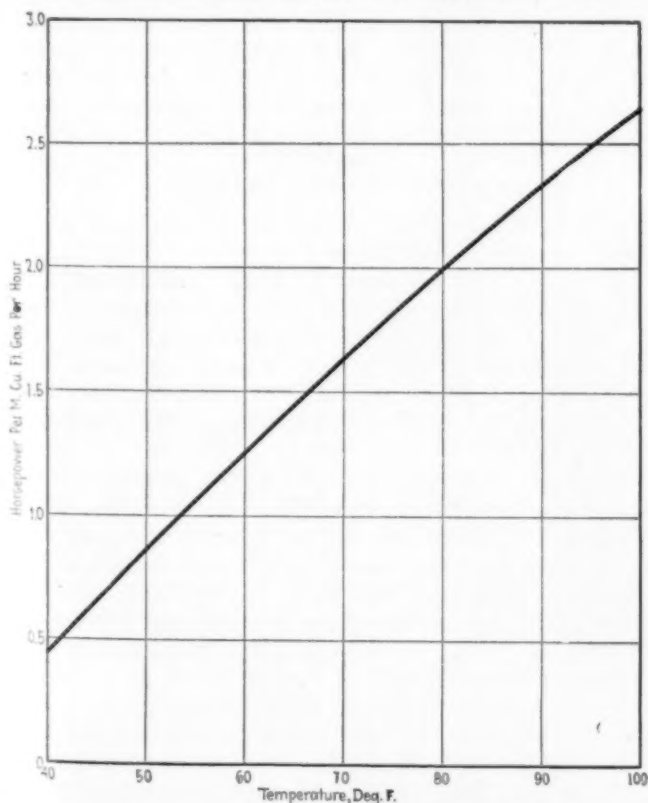


Fig. 3—Theoretical Power Required at Different Temperatures for Dehydration to a Dew Point of 30 deg. F.

The curve is based on isothermal compression and thus represents the theoretical minimum power in each case.

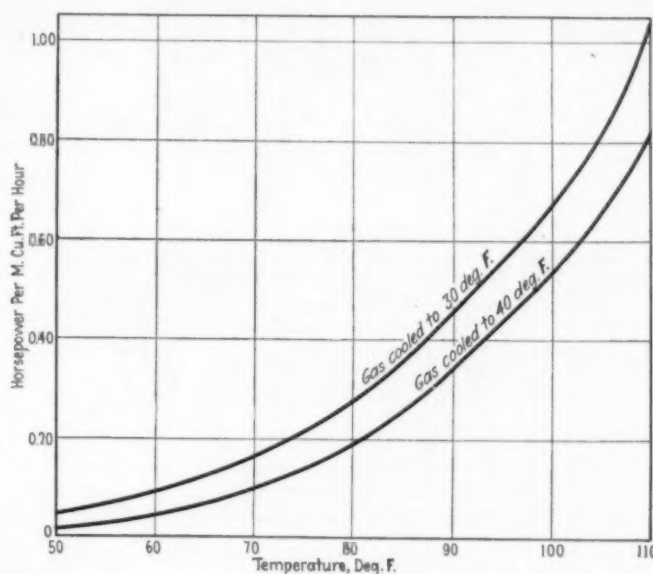


Fig. 4—Power Required for Cooling Gas

These curves show the power when cooling from different initial temperatures to final temperatures of 40 and 30 deg. F. respectively.

calcium chloride because many of the solid hydrates melt at moderate temperatures. Where it is unnecessary to attain extremely high efficiencies of moisture removal, a saturated solution of calcium chloride might be more convenient to apply. In a test using such a solution under conditions equivalent to a theoretical dew point of 42 deg. F., the actual dew point was found to be 48 deg. F.

A saturated solution at 60 deg. F. is theoretically nearly capable of reducing gas to a dew point of 30 deg. F. With a small amount of artificial cooling it should be possible to satisfactorily dehydrate gas with such a solution, even under unfavorable conditions of temperature.

A calcium chloride solution might also be employed to scrub compressed gas, keeping the dew point of the gas entering the distribution system below 30 deg. F.

Concentrated sulphuric acid is a very effective desiccating agent and has the advantage of being applicable in liquid form. The dew point of air in equilibrium with 85 per cent sulphuric acid at 86 deg. F. is—26 deg. F. A satisfactory degree of dehydration can be obtained even with 60 degree acid. In using sulphuric acid it is essential to use such an amount that the strength of the diluted acid is always greater than the equivalent of 50 deg. Bé. At lower concentrations the acid attacks iron and steel, necessitating expensive acid-proof construction. The heat liberated during exhaustion is sufficient to raise the temperature of the system as much as 63 deg. F. without allowing for radiation loss. This assumes the use of 60 degree acid with gas saturated at 79 deg. F. Then the outlet gas would be at 142 deg. F., at which temperature the vapor tension of the acid would be such that efficient dehydration would no longer be possible. With 60 degree acid, therefore, cooling must be employed. If 66 degree acid is used, cooling is theoretically unnecessary, but should probably be employed, as heating of the gas to such high temperatures would be undesirable.

It has been found that the sulphuric acid reacts with certain of the unsaturated hydrocarbons in the gas forming small amounts of tarry matter which must be removed from the system from time to time. The heating value of the gas is not appreciably affected and the



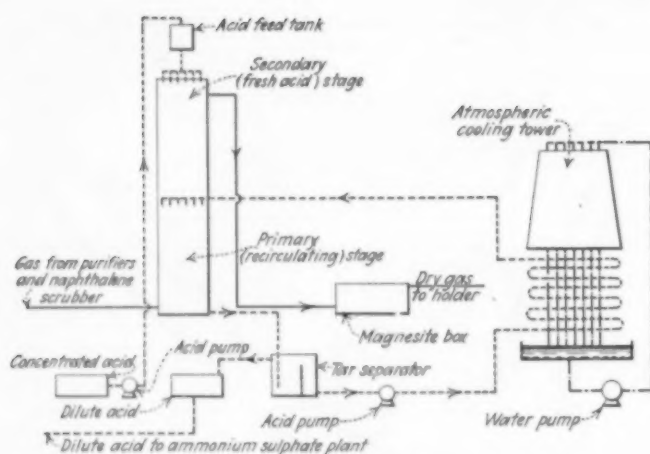


Fig. 5—Proposed Koppers System of Dehydration

In this system the acid from the dehydrating apparatus is employed for the manufacture of ammonium sulphate.

removal of such hydrocarbons would probably be an advantage because it is probable that they consist chiefly of the so-called gum-forming substances.

The principal objection to the use of sulphuric acid for the dehydration of gas is the inconvenience and expense of reconcentrating the dilute acid. In the system developed by the Koppers Co. this difficulty is avoided. This system is shown diagrammatically in Fig. 5. The acid from the dehydrating system is used for making ammonium sulphate in the regular byproduct recovery operations. This can be done using 50 degree acid without any trouble in the operation of the sulphate plant and under normal conditions the amount of sulphuric acid required for dehydration of surplus gas from a by-product coke plant just balances the requirement of the sulphate plant for the same coke plant.

Entrainment of sulphuric acid must be guarded against. It is proposed to place a catch box, filled with magnesium carbonate or some other neutralizing agent, in the line directly after the last stage of the dehydrating apparatus and experiment has proven this to be effective in removing all traces of acid.

#### DEHYDRATION BY ADSORBENTS

In discussion dehydration by adsorbents, reference is had to solid substances that have the property of condensing vapors through so-called surface action. Such substances are characterized by ultra microscopic porosity and a high ratio of surface to volume. Silica gel is the only material of this class that has been commercially employed for drying air. A British plant for drying blast air for blast furnaces employs stationary beds of silica gel. The gel is reactivated by means of hot air and steam. Referring to this plant E. C. Holden said, in *Chem. & Met.*, May 7, 1923, p. 801:

"The gel ratio depends upon the humidity of the inlet air, the temperature of the operation and the dryness required. Thus with a ratio of 0.75 lb. of gel per 100 cu.ft. of air, the following results are obtained at the respective outlet temperatures given using Type C gel:

Outlet Temperature Degrees F.	Per Cent of Total Moisture Removed
80	92.6
85	86.6
90	82.0
95	78.6
100	75.5
105	72.9

The per cent adsorption can be controlled by varying

the gel ratio, or by use of cooling coils to lower the outlet temperature.

"The power and heat required to perform the operation vary with the duty required. In a large installation the gross requirements for each 1,000 cu.ft. per minute of flow are between 70 and 90 kw.-hr. and 3 to 5,500,000 B.tu. per 24 hours, depending upon the original atmospheric humidity and the final dryness required."

In the application of silica gel to the dehydration of gas special problems must be worked out. The material is an active adsorbent for the benzols. It has, however, been shown that, with moist gas containing benzol, the benzol is adsorbed by the silica gel in the initial stages but later is gradually displaced by water until no benzol remains in the gel. It is stated that in operation most of the adsorbable illuminants will be displaced by the moisture and returned to the gas, and the remainder will be recovered from the condenser by steam activation and can be returned to the gas by sprays.

Precautions must be taken in the activation to avoid mixing gas and air. It is said this can be done by the use of steam. In the adsorption of water by silica gel, the heat of condensation is liberated, but it is considered unnecessary to employ any special cooling to take care of this.

#### PROBABLE COST AND ECONOMY OF DEHYDRATION

In the present state of the art it is impractical to make any comparison of various methods of dehydration. It is sufficient for present purposes to state that there are several feasible methods which can probably be applied at a cost not exceeding 1 cent per M. cu.ft. of gas, including fixed charges. The writer believes that in a system of medium size, the direct net saving due to dehydration might be in the neighborhood of 2 cents per M. cu.ft. and in a small system it might be much greater. This is taking into account actual book charges for complaints, meter repairs, drip pumping and other matters. The indirect value of dehydration on account of better service and greater advantage in competition against other fuels and electricity would certainly be greater.

#### POSSIBLE DISADVANTAGES

Disadvantages attendant on the dehydration of gas have been suggested as follows:

1. It might be necessary to scrap water-sealed holders. It is true that the waterless holder would be ideal for dehydrated gas, which would eliminate any frosting difficulties in this holder. However, it is believed that a layer of oil on the water in a water-sealed holder would make the moisture picked up by the dehydrated gas negligible.

2. Dehydration might increase the amount of leakage in the distribution system because of drying out of material in pipe joints and on account of opening up small leaks normally sealed with moist material. The records of companies that have changed from manufactured gas to dry natural gas do not bear out this theory. The trouble could be largely overcome by adopting a system of oil lubrication.

3. In changing a system from saturated gas to dry gas any deposits in the system will tend either to harden or else to become a fine dust and be carried along with the gas. This disadvantage would disappear if the system were kept lubricated with oil and in any event would disappear in time.

# Chemical Industries of MINNESOTA

## *Depend on Agricultural Raw Materials*

By Charles A. Mann

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MINNESOTA is primarily an agricultural state with only thirty per cent of its inhabitants living in cities and towns and these concentrated mainly in the three largest cities, Minneapolis, St. Paul and Duluth. Because of this fact and because of excellent shipping facilities into the state, there are only a few manufacturing industries which use chemicals and still fewer that manufacture chemical products. It is interesting to note, however, that those industries which may be called chemical industries, use about 227,313 primary horsepower and that the coal and coke consumption is in the neighborhood of 1,800,000 tons per year. Most of the chemicals and allied products used in the manufacturing industries in Minnesota are shipped in from widely distributed points. These materials are varied and are consumed in relatively small quantities by a number of industries.

The table shows a list of the commoner chemical materials used, the places from which these chemicals come, the approximate amount used per year and the industries that use them. It will be observed that some of these chemical and allied materials are manufactured in the state although, with the exception of linseed oil, cement, sugar, iron and steel, in quantities insufficient to satisfy the local demand.

There are a number of chemical industries developed in Minnesota. Of these, the linseed-oil industry, ranking second in the country, produces \$33,238,000 worth of products per year. The pulp and paper industry, ranking tenth in this country with three plants produces about \$21,000,000 worth of products. One cement plant produces roughly 4,000 barrels of cement a day. Beet sugar is manufactured by two plants producing 25,000 tons during the campaign. One industry, which is the largest of its kind in the United States, manufactures 125,000 lb. of U.S.P. creosote and guaiacol and their

carbonates a year, but gets its raw material, the hardwood tar, from New York, Pennsylvania, Tennessee and Oklahoma.

Another industry which has gained importance in Minnesota is the storage-battery industry which manufactures about \$1,000,000 worth of batteries per year. As a paint and varnish producer, Minnesota ranks fourteenth with a product valued at \$2,380,000. The iron and steel production is about 425,000 tons per year. Recently a plate glass plant was opened which makes glass for the automobile industry. There is still another plant producing glass, but the amount of glass made is relatively small. One million dollars worth of tanned materials are also produced each year. Some of the other materials produced in the state are coke and gas valued at \$8,628,000, 2,735,000 gallons of coal tar, ammonia, soap, turpentine from wood stumps, lime, casein glue and paints, and drug preparations, cosmetics and the like valued at \$7,235,000. Most of these products are distributed and used in the Twin City trade area comprising Minnesota, Northern Iowa, North and South Dakota, Montana and Northern Michigan, though some of the products are distributed over greater areas. This is true of cement, iron and steel, linseed oil, paints and varnishes, storage batteries, sugar, soap and the creosote and guaiacol.

It is to be expected that iron and steel and cement should be manufactured in Minnesota because of the iron ore resources located near Duluth. Although Minnesota has no coal, lake transportation permits coal, coke, and limestone to be shipped to Duluth. The blast-furnace slag supplies the other raw material for making cement. Because of its location in one of the large cities, a coke plant has been successful because of the demand for metallurgical, foundry, and domestic coke and for city gas. This plant as well as the coke plant at Duluth produces tar and ammonia. All of the coal, however, must be shipped by rail. Although the local market is not great enough to consume all of the production of these two products, cheap lake transportation allows this product to be shipped outside of the state.

It would seem that the glass industry would be logically located in Minnesota because of the great quantity of excellent glass sand available. However, cheap fuel is lacking and the other materials for glass making must all be shipped in from outside of the state. There



is, however, a good market in the Twin City trade area for window and plate glass.

#### INDUSTRIES BASED ON FARM PRODUCTS PROMISE FURTHER GROWTH

Most of the other chemical industries in Minnesota depend on agricultural products for their raw material. Minnesota, North and South Dakota and Montana raise enormous amounts of flax. Much of the flax seed is shipped to the Twin Cities where the oil is expressed and refined. The Twin Cities are the logical places for making linseed oil, because of the local market for linseed oil and because of the excellent shipping facilities for bringing in the chemicals needed for refining and for distribution of the finished product to other markets. It is the linseed oil that has developed the paint and varnish industry in Minnesota and particularly in the Twin Cities.

The beet sugar industry has been successful because beets can be profitably grown in Minnesota primarily due to good soil and climatic conditions and an abundant supply of cheap seasonal labor.

Minnesota is one of the foremost dairying states in the country. As a result, there is available a considerable source of raw material for making casein used in the manufacture of casein glue and paint.

Naturally also, there is a large meat packing industry and this industry furnishes the raw materials for soap making and for tanneries, although the tanning industry has not developed to the extent it should to supply the local demand for the leather. Untanned hides are shipped out of the state to be made into leather which is later returned to the state for the manufacture of shoes and belting.

It is because of the spruce, balsam and pulp woods in Northern Minnesota as well as rivers in this part of the state which allow log floating and large supplies of necessary water that the pulp wood industries have developed. Good railroad facilities are at hand to ship in other raw materials and to send the product to the surrounding markets.

In the cut-over forest lands there is an enormous amount of Norway pine stumps which are suitable for making turpentine and other pine products, but the cost of pulling this type of stump almost prohibits the development of this industry.

#### FACTORS TO ATTRACT NEW INDUSTRIES

Minnesota's mineral resources are limited to iron ore, excellent glass sand and an abundance of marl which might be used for cement making. A number of the agricultural products and by-products are available for

Source, Quantity and Use of Principal Chemicals Consumed in Minnesota

Chemicals Consumed	Where Obtained	Quantity, Tons	Consuming Industries
Alcohol.....	New York and New Orleans.....	150	Alcohol preparations, antifreeze, perfumes and medicinals
Aluminum Sulphate.....	Chicago Heights and East St. Louis.....	20,005	Tanning, paper, water purification
Ammonia.....	St. Louis, Mo., and Niagara Falls, New York.....	18	Artificial ice, cold storage, meat markets, meat packing and fertilizer
Ammonium nitrate.....	Allentown, Pa.....	8	Manufacture of nitrous oxide
Borax.....	California.....	35	Packing industry, cleaning and water softening
Calcium chloride.....	Midland, Mich.....	210	Refrigeration, Kallaston finish and dust allaying
Carbon tetrachloride.....	Locally.....	.....	Dry cleaners
Carbonic acid.....	.....	.....	Carbonated waters
Cautic soda.....	Menominee, Mich., Detroit, Mich., Painesville, Ohio, Pittsburgh, Pa., Chicago, Ill.....	1,830	Insulation, oils, greases, paints, soaps, soap powders, paper and packing
Cement.....	Des Moines, Iowa, Gilmore City, Iowa, and locally.....	79,520	Construction
Chemicals not specified.....	Camden, New Jersey.....	900	Chemical specialties, paper industry, medicinals, analytical laboratories
	Chicago and St. Louis.....	2,400	
	New York.....	150	
	Michigan.....	180	
	Miscellaneous.....	11	
Chlorine.....	Niagara Falls, N. Y.....	3,113	Water purification, laundries, paper and glue
Clay.....	South Carolina.....	13,500	Paper
Cresote and crude oil.....	Shipped in.....	5,800	Wood treating plant
Cornstarch.....	.....	10	Confectionery
Dyestuffs.....	New York.....	11	Paper, tanning, furriers and textiles
Fullers earth.....	.....	1,176	Packing, linseed oil and petroleum refining
Glycerine.....	Chicago.....	30	Printers rolls, toilet preparations, anti-freeze
Lead oxide.....	Joplin, Mo.....	1,080	Storage battery
Lime.....	Duluth and Mankato, Minn., and Sherwood, Wis.....	7,790	Construction and paper
Linseed oil.....	Locally.....	4,500	Paints
Magnesite.....	Portersville, Calif.....	400	Metallurgy
Oils.....			
Sulphonated eod.....	Roston, Mass.....	20	Tanning and soap
Cottonseed.....	Texas.....	380	
Paint pigments.....	Easton, Pa.....	4,500	Paint and tires
	Akron, Ohio.....	210	
Pig lead.....	St. Louis, Mo.....	2,000	Storage battery
Rosin.....	Central and Southern States and Milwaukee, Wis.....	360	Soaps, paper and varnishes
Rubber.....	New York.....	450	Tires
Salt.....	St. Paul, Minn.....	300	Dairying, meat packing, food products, tanning, paper, packing and soap making
	Akron, Ohio.....	240	
	Michigan.....	3,330	
	Locally.....	2,250	
	Duluth, Minn.....	280	
	Superior.....	180	
Rock.....		10,300	
Refined.....		7,600	
Soap.....	Local.....	75	Tannery and textiles
Soda ash.....	Detroit, Mich.....	280	Tanning, soap, packing, boiler compound and glass
	Barberton, Ohio.....	350	
	Wyandotte, Mich.....	200	
Sodium bichromate.....	Baltimore.....	13	Linseed oil
Sodium bicarbonate.....	Syracuse, N. Y.....	50	Linseed oil
Sodium nitrate.....	Chili.....	170	Packing and tanning
Sodium nitrite.....	Chicago, Ill., and Seattle, Wash.....	60	Packing
Sodium silicate.....	Philadelphia and Utica, Ill.....	8,460	Paper, packing, wall board and adhesive
Sodium sulphide.....	Philadelphia.....	30	Linseed oil
Sodium thiosulphate.....	Chicago, Ill.....	300	Paper
Sugar.....			
Brown.....		420	Packing
Refined.....		210	
Sulphur.....	Gulf Coast.....	23,000	Paper pulp
Sulphuric acid.....	Chicago, Ill.....	665	Leather, storage battery, paper, pickling iron and steel and fertilizer
Tanning.....			
Hemlock.....	Wisconsin.....	700	Tanning
Quebracho.....	South America.....	75	
Turpentine.....	Savannah, Georgia and Charleston.....	1,200	Paints
Washing soda.....	Syracuse, N. Y.....	60	Textiles and laundries
Soda crystals.....		60	
White lead.....	Chicago, Ill., and St. Louis, Mo.....	120	Paint
Zinc oxide.....	New Jersey.....	2,400	Paint

conversion into useful chemical and allied materials and there are great possibilities in using wood wastes from the lumbering and paper and pulp industries.

As previously pointed out transportation in Minnesota is excellent. The state has nine railroad systems, six of which have direct eastern connection and four with connection to the western coast, with very good terminals in St. Paul and Minneapolis. There are 28,000 miles of road bed in Minnesota, 800 miles of concrete road and additional excellent roads for motor transportation.

Great Lakes transportation is of great importance to Minnesota, Duluth being the Minnesota port. Nearly all of the coal used in Minnesota enters this port and iron ore, iron and steel, cement, grain and other products are shipped out of this port. Transportation for Minnesota will be greatly improved when the Mississippi River barge line is placed in operation in the Spring. This will permit cargoes to be shipped up the Mississippi to both St. Paul and Minneapolis.

Labor generally is very satisfactory with an abundance of skilled labor in the larger cities. Strikes and labor troubles are hardly known throughout Minnesota.

The total amount of hydro-electric power development consists of 250,000 primary horsepower with 700,000 primary horsepower made by steam plants. Fuel for power should become cheaper through river transportation especially if Illinois coal is purchased.

Minnesota has no fuel except peat. It is estimated that Minnesota has 6,000,000 tons of good peat. There

are possibilities that this will be converted into more suitable fuel through briquetting or using it as a powdered fuel. Experiments are being carried on to use it to make producer gas. This seems to be a potential fuel.

It is doubtful if chemical industries will develop rapidly in Minnesota primarily because of the lack of raw materials. However, river transportation may reduce the cost of shipping coal and raw materials so that it would be profitable to make some of the chemical materials used in the industries.

With lower priced electric power made from steam through much cheaper coal, it should be feasible to make electrolytic chlorine for water treatment and for the paper and pulp industry instead of shipping it in cylinders from distant points, and there would be a market for the caustic soda for soap making.

A glass industry should be organized in Minnesota because of the excellent glass sand. This industry, however, will depend on cheap fuel which may be obtained through river transportation. Sodium silicate likewise could be produced in Minnesota. It seems reasonable also to expect the steel industry and the cement industry to expand particularly along the Mississippi River. All of these industries and undoubtedly others could develop in Minnesota if a cheap fuel were available. The demand for chemical products locally is great and the excellent shipping facilities makes it a simple matter to distribute these manufactured goods throughout a considerable area surrounding Minnesota without incurring undue expense.

## Growth of Canadian Chemical Industry

Some facts concerning the chemical and electro-chemical field in Canada were contained in a recent review by H. W. Matheson, vice-president of the Canadian Electro Products Co., Ltd.

"The production of chemicals and allied products and the development of new chemical industries made steady progress in Canada during the year 1926. A considerable number of new chemical products came into production in 1926 and others will come in early this year. The principal of these is the manufacture of cellulose acetate silk, for which purpose a large plant is being built at Drummondville, Quebec, at an estimated cost of \$10,000,000. The development of the new lacquer paints and varnishes has involved the utilization of solvents not previously utilized in Canada on a large scale. The manufacture of these from calcium carbide has been

developed by the Canadian Electro Products Co. during the past year and in sufficient quantities to supply the Canadian demands.

"No statistical figures are yet available for the year 1926. The accompanying table, however, gives the comparative selling value of the various classifications of chemicals and allied products as applied to the years 1924 and 1925.

"In the electro-metallurgical field the greatest development in recent years has been the establishment of the enormous plant of the Aluminum Company of Canada at Arvida on the Saguenay River. This plant has come into operation during the past year and marks an era in the utilization of hydro-electric power as applied to electro-metallurgy in Canada. The price of power in the United States is becoming so high that it cannot be utilized in large quantities in the electro-chemical and electro-metallurgical field, where cheap power is necessary, and the transfer of the Aluminum Company's operations to the Saguenay, it is believed, is the beginning of the establishment of a number of electro-metallurgical and electro-chemical developments in eastern Canada.

"Taking into consideration her relatively small population, spread over such a wide area, Canada continues to make slow but satisfactory progress in the development of her chemical industries. A number of large companies maintain efficient research and development staffs so that the industry is kept in touch with commercial and industrial developments throughout the world. We are thus assured that the results of foreign and domestic research will be utilized in Canada as economic conditions warrant."

Product	Selling value	
	1924	1925
Soaps, washing compounds, toilet preparations .....	\$15,965,000	\$17,388,000
Fertilizers and fertilizer materials....	3,395,145	3,727,430
Aluminum and aluminum ware.....	7,700,000	9,137,305
Aerated and mineral waters.....	6,354,358	6,877,524
Miscellaneous chemical industry, including adhesives, baking powder, boiler compounds, celluloid and artificial leather, insecticides, flavoring extracts	10,294,000	10,700,000
Acids, alkalis and compressed gases..	26,241,000	27,483,000
Paints, pigments and varnishes.....	20,200,824	21,900,800
Explosives, ammunition, fireworks and matches .....	13,310,000	12,313,000
Medicinal and pharmaceutical .....	13,350,000	13,987,000
Inks, dyes and colors .....	2,656,400	2,749,800
Coal tar and its products .....	2,637,500	2,623,000
Wood distillation and wood extracts...	2,283,420	1,990,000
Electrolytic zinc .....	6,090,000	7,557,000
Total .....	\$130,477,647	\$138,433,859



# Gas Industry Needed in NORTHERN OHIO

## to Supplant Failing Natural Supply

By James R. Withrow

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OHIO is rapidly becoming the Belgium of America. For a century and a half Ohio has been the cross-roads between the eastern seaboard and the pioneer developing West. Ohio, the beginning of the old Northwest Territory, was the great highway. Through it stretched the old National Road. Even in the century before the last there was dropped at the crossings and along the highway, skilled artisans from the seaboard and the old country. Thus many industries started over the State. Besides this heritage, of great importance is Ohio's location with reference to fundamental resources. Situated on the lakes between the great iron and coal resources of the nation with much of the latter within her own borders, Ohio has much level land for a great agricultural development and for manufactures. Great deposits of salt underground and the ready availability of natural gas, petroleum and sulphur from the South complete the picture of a strong foundation particularly for the chemical industry. When to this is added the resources within the State of coal, limestone, clays, shale and peat, all the industries are provided for and the future is assured, for the chemical industry is essential to all other industries and prospers as they prosper. Open markets over a wide area, raw materials, cheap fuel, good shipping facilities and satisfactory labor with a population still largely American, tell the story of Ohio progress and gives rational grounds for future development.

As a result, Ohio possesses 11,000 manufacturing establishments with 700,000 wage earners whose wages and salaries are \$1,200,000,000. The total raw material consumption is more than \$3,000,000,000 and the value of products is \$5,000,000,000. The primary horsepower consumed is 3,300,000 and the coal consumed 29,000,000 tons. Among those industries largely chemical, Ohio has the largest rubber and match factories.

This highly-developed status has been accompanied by complete loss of some industries. With the depletion of natural gas, much of the early glass industry disappeared as did the manufacture of charcoal iron when the lake ore appeared. Also the linseed oil industry has been greatly reduced, since flax culture moved toward the Northwest. However, a chemical engineering residuum was left, in that oil-crushing machinery for the world is now made in Ohio, as for instance at Piqua.

In substantiation of the introductory estimate of the abiding foundation of the chemical industry of Ohio we have only to list the main industries of Ohio consuming chemicals as ascertained by the Bureau of the Census (1923). The other figures of this report are for 1925 and 1926.

Ohio Industries that Consume Chemicals

Industry	No. of Plants	Wage Earners (Average) No.	Coal (Short Tons)	Salaries (in Thousands of Dollars)	Wages (in Thousands of Dollars)	Materials (in Thousands of Dollars)	Products (in Thousands of Dollars)
Artificial stone.....	95	609	5,276	184	752	1,232	3,179
Babbitt metal.....	5	24	617	30	37	430	600
Paper bags.....	12	934	6,161	281	911	6,238	8,608
Beverages.....	203	1,855	104,843	902	2,668	5,567	12,837
Brass and bronze.....	98	4,202	13,835	1,675	5,944	11,871	24,090
Chemicals.....	60	5,165	771,779	2,393	7,496	22,471	44,761
Chewing gum.....	3	77	58	25	59	141	290
Clay products, not pottery.....	276	16,501	2,222,257	3,004	23,109	16,756	57,034
Cleaning preparations.....	28	139	512	367	136	1,002	2,424
Copper and tin.....	153	2,856	7,124	1,288	3,792	11,786	20,443
Druggists' Preparations.....	22	403	1,490	378	351	1,153	3,048
Electro-plating.....	37	309	277	88	504	229	1,131
Emery and abrasives.....	6	297	6,090	102	335	608	1,446
Enameling and japanning.....	8	190	2,823	113	333	404	1,201
Explosives.....	11	240	9,859	167	323	1,213	1,994
Fertilizers.....	22	802	15,863	523	946	5,515	8,395
Flavoring extracts.....	19	126	1,417	241	161	1,153	2,395
Galvanizing.....	5	54	330	36	78	251	466
Gas, manufactured.....	19	176	48,275	93	271	437	1,549
Glass.....	34	9,539	460,653	1,637	11,647	11,622	33,211
Gold and silver refining.....	3	14	.....	3	19	588	651
Grease and tallow, not lubricating.....	31	537	43,771	188	713	2,556	4,022
Ink.....	10	347	9,688	374	537	2,673	4,982
Leather, tanned.....	22	1,945	41,719	609	2,529	11,553	17,320
Lime.....	22	1,402	228,638	255	2,025	3,005	7,955
Lubricating grease.....	11	114	2,765	255	144	1,196	2,405
Beet sugar.....	5	459	58,133	387	642	3,807	5,351
Vinegar and cider.....	4	25	33	21	25	121	248
Minerals and earths treated.....	22	628	48,270	238	881	1,222	3,338
Paste.....	10	32	533	30	35	326	638
Oil, not petroleum.....	18	113	2,695	227	194	2,088	3,349
Paint and varnish.....	90	2,968	62,580	3,547	3,858	27,635	49,422
Paper and wood pulp.....	53	7,171	951,544	2,450	9,558	46,781	66,949
Perfumes and cosmetics.....	17	469	678	527	438	2,194	6,743
Petroleum refineries.....	14	3,102	558,415	5,353	4,201	39,488	51,559
Pottery and porcelain.....	101	14,401	304,121	2,848	17,273	13,693	42,716
Rubber tires and tubes.....	53	42,476	973,389	18,645	67,247	217,184	391,316
Salt.....	6	847	207,492	436	1,120	2,230	4,899
Soap.....	26	2,927	169,757	1,408	3,379	35,093	44,993

Details of the chemicals consumed, their origin and consumption are unknown to statistics of either chambers of commerce or state or national census tables. Ohio, however, has a growing chemical industry, well established and produces most of the chemicals demanded within her own borders. Nevertheless, the amount imported from other states is also large.

#### MANUFACTURING DISTRICTS IN OHIO

As is customary, manufacturing in Ohio is concentrated in districts surrounding individual cities. A brief survey of the activities in these cities will illustrate the industries now established which are consumers of chemicals and give a clue also to the type of demand for chemical products.

**Akron** produces artificial stone products, beverages, baking products, clay products, metal, foundry and machine-shop products, and rubber goods. The city of Akron alone produces \$330,000,000 annually of rubber goods in twenty establishments. The total number of establishments is 223; of wage earners, 45,000; the wages, \$70,000,000 and value of products, \$400,000,000.

**Cleveland.** This city produces aluminum products, artificial flowers, stone products, textiles, beverages, stains, non-ferrous and ferrous-metal products, baking products, brushes, railway equipment, chemicals (valued at about \$12,000,000 a year), clay products, clothing and packing products; \$40,000,000 in stamped and enameled ware, oil and gas, structural iron, tools and wire work. The number of establishments in Cleveland is about 2,000; the wage earners, 140,000; wages, \$200,000,000; and value of products, \$1,100,000,000.

**Columbus.** Although the capital city of the State, Columbus has 500 manufacturing establishments with about 30,000 wage earners receiving about \$40,000,000 in wages with a value of products of about \$200,000,000. These consist largely of artificial stone products, boots and shoes, railway equipment and repairs, sheet metal foundry and machine shop work, wire, steel forgings, motor vehicle parts, paints and varnish, printing and publishing and meat packing.

**Toledo.** This city has about 600 establishments with about 40,000 workers earning about \$60,000,000 wages and with products valued at about \$400,000,000, consisting largely of textiles, non-ferrous metal work, baking products, dairy products, railway equipment, women's clothing, coffee and spice roasting and grinding, electrical equipment, flour-mill products, foundry and machine products, gloves, machine tools, paint and varnish, petroleum products, printing and publishing and structural iron work.

**Youngstown.** This city has about 166 establishments employing 20,000 workers earning \$35,000,000 in wages. Products are valued at \$270,000,000, consisting largely of artificial stone products, baking products, electrical machinery, iron and steel, foundry and machine-shop products and printing and publishing. (The district of Cincinnati, Hamilton and Dayton is treated separately and not included in this account.)

Ohio's chemical industry is based primarily upon available raw material resources, fuel, lime, salt and water, but is also directly connected with the State's industrial markets. No arrangement could be more logical with reference to raw materials and markets.

**Soda Ash.** Ohio is said to rank first in the production of soda ash; at least, the major production in the United States is within 100 miles of Ohio territory.

There are two large plants operating. Surveys have been made for a third plant.

**Rubber.** Ohio ranks first in the United States in the manufacture of rubber goods. Ohio's rubber industry as a whole requires about 55,000 wage earners and officials in 104 establishments; consumes 214,093 primary horsepower and 1,099,980 tons of coal. Salaries and wages are \$92,500,000. The cost of materials is \$227,608,494, and the value of product is \$413,120,000.

**Lime.** Ohio ranks first in the production of lime. Its finishing lime is the country's standard, Ohio furnishing the bulk of the supply. From the point of view of value, building operations use more lime than all the other industries put together. Glass manufacture comes next, followed by agriculture, paper mills, metallurgy and chemical industries.

The dolomitic lime industry in the State is much larger than the high-calcium lime industry because of two reasons:

(1) Greater market.

(2) The inherent quality of dolomitic lime makes it easier to store without danger of serious darkening.

Ohio possesses 22 lime plants, with 1,500 employees consuming 9,537 primary horsepower and 228,638 tons of coal. The salaries and wages are \$2,300,000 annually. The cost of raw material is \$3,000,000, and the value of products is \$8,000,000.

**Glass Production.** Ohio is the leading state in glass-ware production in the United States and stands high in production of glass enameled ware. The state ranks fourth in all glass manufacturing. Ohio is said to possess 62 establishments. Thirty-four of them have 10,200 salaried officers and wage earners. The industry consumes 29,378 primary horsepower and 460,653 tons of coal. Salaries and wages are \$13,000,000. The cost of raw material is \$12,000,000, and the value of product is \$33,000,000. Because of the rising cost of natural gas and also because of the abandonment of the hand-blown methods of manufacturing, the window glass production is decreasing. Ohio now produces 12,527,100 sq.ft. of window glass with a value of \$838,890.

#### OHIO CERAMIC INDUSTRY

Ohio ranks first in the United States in the production of clay or ceramic products, but no terra-cotta is produced. The field of products is wide. The state possesses about 23 enamelware plants, 7 art potteries, 25 sewer pipe plants, 38 refractories plants, 30 drain tile plants, 90 common and face brick plants, 12 paving brick plants, 4 abrasives plants, 27 building tile plants, 27 stoneware plants, 25 porcelain and tile plants, 55 china or general whiteware plants. There are about 62 glass plants in Ohio.

Although there are leading large plants in each branch of ceramic lines, Ohio's prestige in each branch of ceramic production is due more to the high quality of wares produced economically by many small factories. It produces one-fourth of the country's ceramic products. About \$100,000,000 of clay goods alone is produced annually in about 400 plants in Ohio.

The plants are well scattered, no segregation, no district monopolies. The Hocking Valley is famous for brick, Tuscarawas valley for sewer pipe, East Liverpool for dinner wares and electrical porcelain.

White wares are extensively manufactured in the Ohio River Valley, although there are no clays of the highest qualities in the district. Central shipping loca-



tion, availability of skillful labor and the momentum of an established industry combine to hold the china ware in Ohio.

Much clay is imported from England, but not as much as formerly; Georgia kaolins are finding wide use in Ohio.

*Muriatic Acid.* As to the tonnage of HCl produced in the United States Ohio ranks first with a total production of 38,161 tons. There are 3 plants operating in the State.

*Char.* Ohio ranks highest in the production of absorbent char for gasoline extraction and color adsorption.

*Sand and Gravel.* Ohio ranks first in the production of sand and gravel, most of which is used in the building industries. In the order of importance, the uses are for molding, building, furnaces, paving, grinding and polishing and glass manufacture.

*Pig Iron and Steel.* Ohio ranks second in the production of pig iron. About 3,800,000 tons is ordinarily produced each year. The steel produced in the state per annum has a value of \$250,000,000.

*Salt, Bromine and Calcium Chloride.* Ohio ranks third in the United States in the production of salt, though the production is not heavy. Ohio has 6 salt plants, with 1,050 employees and wage earners. It has 6,193 primary horsepower, consumes 207,492 tons of coal. The salaries and wages are \$1,560,697. The cost of raw material \$2,230,556 and value of products \$4,899,251. Ohio has also ranked second or third in the production of the valuable byproducts of salt such as bromine and calcium chloride. Calcium chloride is also marketed as a byproduct from the ammonia-soda plants of the State.

*Gypsum.* Ohio ranks third among the different states in the Union in gypsum production. The production is 363,000 tons annually. Nearly all the gypsum mined in Ohio is calcined. The workable area is in Ottawa and Erie counties. The gypsum, which is stratified in limestone, has a maximum thickness of 17 ft. It is used for making plaster, plaster board and statuary, to retard the setting of cement and in connection with the plate glass industry.

*Sulphuric Acid.* Ohio ranks fourth in regard to the amount of mixed acid produced. Ohio has three plants operating for the production of mixed acid ( $H_2SO_4 + HNO_3$ ) with a total production of 941 tons annually. Ohio ranks sixth in the United States in the production of sulphuric acid. There are 11 plants with an annual production of 464,827 tons (50 deg. Bé. basis) of which 366,608 tons (50 deg. Bé. basis) is put on the market and has a value of \$3,415,310.

*Cement.* Ohio ranks tenth in cement production. There are ten cement plants operated in Ohio with an output of 34,000,000 bbl. annually. Portland cement is made from a mixture of about 75 per cent limestone and 25 per cent of shale or clay. It is also made from a marl which has about the desired proportion of lime and clay substances. All three substances are abundant in Ohio.

*Beet Sugar and Starch.* Ohio possesses an active beet sugar industry with five plants in the northwest portion of the State. There is one starch plant in the center of the State.

*Abrasives* such as grindstones, pulpstones, oil stones and scythe stones are also manufactured from Ohio sandstone. Grindstones and scythe stones are largely

obtained from the Berea bed, although Pottsville, Monongahela and Dunkard beds are also worked for this purpose. The principal regions for production are in Cuyahoga and Lorain counties, but other quarries are in Holmes, Morgan and Washington counties.

For years Ohio has been a great producer and refiner of cadmium and its sulphide. The Grasselli Chemical Co. of Cleveland manufactures most of it.

There are 17 companies in Ohio manufacturing organic dyes and related products. In addition to these chemicals and related products, Ohio manufactures zinc and zinc oxide, powdered sulphur and sulphur derivatives, caustic soda, arsenicals, intermediates and accelerators (rubber), tanning chemicals, ammonia, ammonium sulphate, primary coal-tar products, explosives, lithopone and other pigments.

#### ECONOMIC FACTORS IN THE INDUSTRIAL CHEMICAL DEVELOPMENT OF OHIO

Salt, coal, clay, shale and limestone underground and iron ore and sulphur are readily available; efficient transportation by rail, lake and river; skilled labor, still largely American; power cheaply developed and growing markets give Ohio all the attractive economic elements for a great development in chemical manufacture.

*Natural Gas Situation.* The outstanding economic factor which will force considerable development in Ohio in the immediate future is the dwindling supply of natural gas. At present Ohio ranks second in the United States in the consumption of natural gas. About 136,000,000 cu.ft. of gas or about 17.1 per cent of the total annual consumption in United States is consumed in the State, while only 71,854,000 cu.ft. of gas is produced each year and neighboring states threaten to curtail supply.

Ohio ranks fifth in the production of natural gas, 8.4 per cent of the total production in the United States being produced each year. The gas fields are situated in almost the same territory as the oil, but have a greater area. A tremendous amount of gas has been used, mainly for domestic purposes. The fields either have been or are in danger of being exhausted. Much industrial development of the past has ceased because of failure of local gas supply. Now the great problem is gas for household and municipal heating. The community used to the convenience of natural gas will never consent to accept cessation of supply of gas in some form. As a result of the recession of the natural gas supply now going on, there must come in the next decade a tremendous investment and development in gas manufacture with all the attendant byproduct production.

*Coal.* Ohio has about 45 coal beds spreading over 29 counties, 25 of them are workable in a large way, 12 of these are regularly mined for railroad shipment. About 32,000,000 tons of coal is produced annually. Middle Kittanning coal and Upper Freeport coal and the Pittsburgh are the largest beds. Their composition differs but little. All are bituminous and all are steam coals. Only small amount of Ohio coals are used for coke making. Its use for gas is hindered also for two reasons:

- (1) The discovery of natural gas.
- (2) Ohio coals do not coke well. The coke produced annually in Ohio is about 3,000,000 tons.

Ohio has a large amount of low-grade coal. If this is used on the ground for the manufacturing of clay

products it will bring from 15 to 20 times the returns which would be obtained by shipping the coal itself.

*Primary Horsepower and Coal Consumed.* But little information is available upon the current distributed from power stations. The power consumed in Ohio annually is 3,307,726 horsepower as reported by 10,255 establishments in the year 1923. The prime movers consist of 6,166 steam engines and turbines with a total horsepower of 1,843,209; 1,279 internal combustion engines with a total of 141,079 horsepower; 186 water turbines with a total of 12,478 horsepower; 119,536 electric motors driven by purchased current have a total of 1,310,960 horsepower.

There are also 48,858 electric motors driven by current generated in establishments reporting a total of 980,219 horsepower. In addition 202,038 long tons of anthracite and 28,509,415 short tons of bituminous coal are required each year.

*Clay and Shale Resources.* Ohio possesses over 20,000 sq.mi. of shale suitable for brick and ceramic manufacture. There are over 13,000 sq.mi. of clay with a total geological thickness of these materials of 2,500 ft. Many are in the Dunkard, Pennsylvanian, Mississippian, Upper Devonian. There are 15 shale beds and 10 clay beds of wide distribution over the eastern half of the State. Either clay or shale of fair quality may be found in almost any locality. The clay and shale of Ohio is mined by:

- (1) Hand working and open pits.
- (2) Steam shovel costing from 15 to 50 cents a ton.
- (3) Drift mining costing 50 cents a ton.

Yield from stripping runs as high as 3,400 tons per acre foot and from drift mining 2,000 tons or 60 per cent of strip mining. A 7-ft. bed, for example, will give 4,000,000 bricks per acre and a 50,000 per day brick plant works 4 acres per year on a 7-ft. bed.

There is no kaolin in Ohio. The white-ware industry of the State, however, is centrally situated with reference to the materials which it must draw to its chief source of fuel. The kaolin is brought from North Carolina, Florida and England. The flint comes from Pennsylvania and Illinois, the spar from Maine and Canada and the ball clay from Kentucky and England. Exceptional flint clays for refractory ware occur in the southern and southeast portions of the State. They come from six geological horizons. The flint clay is highly refractory, softening at 3,000 to 3,100 deg. F.

Plastic clays are of the utmost importance to the ceramic industry and come from seven geological horizons for building brick, stoneware and the like. On the Lower Kittanning plastic clay alone are operating over 100 plants producing a wide variety of products.

The plastic clay has good working properties, good drying properties and good body structure. The shales have great working properties. They are widely used at Cleveland, Taylor, Portsmouth, Hanover and Wooster.

The relation of raw materials to manufacturing cost is important. The cost of production of sewer pipe for example per ton of pipe is divided as shown in a table which will follow.

Clay plants and many other industries in the State are situated within or border on the coal fields. The clay and coal often are drawn from the same property, as for example the clay in Tuscarawas County, Irondale and Hocking. Coal and clay are often mined from the same entry as at Cambery and Oak Hill. Natural

gas is also a factor in the location of this industry.

The silicate or clay products industry of Ohio has been so fully discussed as to indicate the economic factors which make this industry really stand at but the beginning of its development in this State. Ohio has vast clay and silica resources; geologists have estimated them to be inexhaustible. However, the high-grade refractory flint clay of which there is a vast quantity, is now for the most part unavailable and made so by man's wasteful and ignorant mining management.

#### Cost of Production of Sewer Pipe

a. Coal .....	\$2.42
b. Power and supplies.....	1.62
c. Clay .....	1.20
d. Preparation (grinding, screening)...	0.55
e. Pressing .....	1.09
f. Drying .....	0.88
g. Firing (labor) .....	1.25
h. Losses .....	1.92
i. Overhead .....	1.11

Cost of 1 ton.....\$12.04

*Limestone Resources.* The limestone resources of Ohio occupy an area of over 21,000 sq.mi. covering the whole western half of the State. They are largely dolomitic, although some high-calcium stone exists. The highly desirable plastic nature of the limes produced in northwestern Ohio illustrates the value of this resource.

*Glass Resources.* Ohio is well situated as to raw material for the glass industry. There are no first-class deposits of glass sand in the State, but excellent shipping routes enable much sand to be brought from the Fox River Valley of Illinois, Rockwood, Mich., or the Oriskany districts of West Virginia, Maryland and Pennsylvania.

The northern Ohio limestone field furnishes raw material for glass industry throughout the United States not only because of the purity of the stone, good manufacturing plants and freight service, but also because of the low-iron dolomites of the district which are considered desirable for glass making. Two soda ash plants are in Ohio, so it is readily seen that the raw materials for glass making are available to Ohio manufacturers without excessive transportation costs.

*Petroleum.* Ohio ranks twelfth in the production of petroleum. About 7,330,000 bbl. of petroleum is produced each year. It is derived from three localities in the State: the Lima field, the central Ohio field and the eastern Ohio field. Total depth of wells range from 1,100 to 2,600 ft. In the Northwest the oil contains sulphur, and that from the other two fields resemble the light oils of Pennsylvania and West Virginia. The oil is alleged by refiners to come in two grades, "Pennsylvania" and "Corning," with a price differential in favor of the "Pennsylvania" grade.

*Iron Ore.* Iron ore deposits of Ohio are associated with coal strata. These deposits are thin and hard to work. Consequently they cannot stand the competition of the ores from Lake Superior and Alabama. The last iron furnace closed down in 1918.

*Peat.* Ohio has more than 155,000 acres of peat averaging more than 10 ft. deep. In Europe peat is used in the manufacturing of industrial coke, illuminating and fuel gas. It is also used for the manufacturing of tar, ammonium sulphate, ethyl alcohol, dye-stuffs, tannic acid, paper, woven fabrics, building boards, mattresses and sanitary appliances and as a



filler for fertilizer. Little of this is utilized at all in Ohio.

**Strontium.** The northern Ohio limestones possess unique deposits of strontium minerals commercially unworked.

**Markets and The Great Ohio Ship-way.** The chemical industry of Ohio, like that of the eastern seaboard, has had a normal development starting with a pioneer agriculture. In addition to agriculture, chemical markets are connected largely with the development of manufactures. Ohio has had a normal and rapid industrial development. Its chemical industry therefore is actively growing. This will continue as active chemical markets develop with the inevitable growth of manufactures in the State. The agriculture of the State will of course continue to develop demand for fertilizers and agricultural chemicals under the educational program in agriculture.

The advent of the great ship-way across Ohio which is advocated between Lake Erie and the Ohio River, will greatly expand all manufacture in the State, by bringing lake iron and Ohio coal closer together with minimum handling.

#### ORGANIZED RESEARCH AND DEVELOPMENT AN ADVANTAGE TO INDUSTRY

In addition to the economic attractions of Ohio, there must become increasingly effective the large number of commercial research organizations within the State. To these research resources should be added those supported by the State and nation.

**U. S. Bureau of Standards.** The Ceramic Experiment Station at the Ohio State University under the leadership of Stull and Bole (in the Bureau of Mines) and now of McDowell in the Bureau of Standards is the research branch of the Bureau of Standards dealing with ceramic problems. It is working on such questions as the fit of glazes to bodies to prevent crazing; power-house refractories; set of standards for heavy clays to determine their field of usefulness; spinel refractories; eutectic enamels; use of X-rays in ceramic vitrification studies; and English versus American china clays.

**The Ohio State Geological Survey.** The Ohio State Geological Survey is one of the best economic surveys of the past forty years under the able leadership of Edward Orton, Sr., Edward Orton, Jr., and Bownocker. The bulletins of the original survey filled seven large volumes. The present survey has over 30 volumes of from 200 to 600 pp. each. As Ohio is largely a non-metal State, this survey is a classic for non-metals, oil, coal, gas and clay.

**The Engineering Experiment Station of the Ohio State University.** This Engineering Experiment Station is the best housed in the United States. It was established by the State Legislature at the suggestion of Brig.-Gen. Edward Orton, Jr. Under the leadership of Orton, Coddington and Hitchcock, it has added many researches to industry. The work is on engineering problems for publication for the benefit of industry. Much financial support for this work comes from industry. The coal and iron operators of Ohio, the National Lime Association and now the ceramic industry is actively financing research projects.

The station is about thirteen years old. It has expended on research about \$90,000. It has one of the best buildings in the country devoted exclusively to

engineering experiment. The nucleus is worth \$225,000. The final plan will cost about \$1,500,000. It has published 33 bulletins and 14 circulars of researches: in chemical engineering and industrial chemistry, 7; ceramics, 5; mine engineering, 4; civil engineering, 5; automotive and mechanical engineering, 8; electrical engineering, 14 (circulars); metallurgical engineering; 4. It is financing about 20 active projects. It has a program of \$40,000 expenditure in near future with emphasis in co-operation with Ohio ceramic industries.

**Ohio Ceramic Industries Association.** The ceramic industries have organized a state association and have worked out with the Engineering Experiment Station of the Ohio State University a program of research and education. They are intelligently seeking ways and means already provided of maintaining their productivities and their economic status. This organization possesses 75 members with 100 plants. These are the heavy producers. They constitute 90 per cent of the white-ware business and 40 per cent of the heavy clay work. Glass will soon be brought in. Between 40 to 100 per cent of the refractories manufacturers are in the organization. At the request of the Engineering Station of the Ohio State University, the State Welfare Department is erecting a building to be equipped with semi-commercial machinery by the Association. The Engineering Experiment Station will also have the technical control of operating the State Brick Plant (convict labor). The Experiment Station is financing a survey of clay manufacture and mining in the State. They have covered two-thirds of the heavy clay plants to accurately tabulate the industry and to define troubles in manufacture.

#### CHEMICAL INDUSTRIES WHICH MIGHT BE PROMOTED IN OHIO

Although Ohio produces every kind of chemical which can be economically made within the State, nevertheless it will add to this list as market and economics permit. This means that there is little to be emphasized in the shape of needed expansion in chemical manufacture. There is, however, obvious opportunity for production of many materials based upon the resources discussed.

Any industry based upon fuel requirements is a possibility. The manufactured gas is an inevitable product. The low-grade coal should attract zinc smelters, clay and ceramic plants and the like. The whole clay industry is a case in point also because of the clay resources. Such chemical industries as are based upon common salt, will find opportunity. Cement manufacture should expand as the market justifies it. Magnesium derivatives should be actively developed.

Then there will be the steady growth of all the chemical production which is demanded by an increasing density of industrial development. The outstanding opportunity for growth is in the manufacture of gas for domestic and industrial purposes. In addition there will be a demand for electrochemical developments which can exist on off-peak loads of the growing power plant developments of the State.

Between Portworth and Huntington along the Ohio River, there is a vast and rich coal field and, hence, it is the best place in the Ohio Valley, and perhaps in the country, for building large steel plants. At least one gigantic plant should take advantage of this situation in the near future.

# On the Engineer's Book Shelf

## Economics for Chemical Engineers

CHEMICAL ENGINEERING ECONOMICS. By Chaplin Tyler, Assistant Editor, *Chemical & Metallurgical Engineering*. McGraw-Hill Book Company, Inc., New York. 271 pp. Price \$3.50.

Reviewed by Donald B. Keyes

With the publication of this book Mr. Tyler has brought chemical engineering one step nearer its goal, i.e., a place among the great professions of the world. The last alibi of the universities is gone; they can no longer maintain that they are unable to equip their students with an adequate knowledge of the fundamental economics of this profession. Nor will there any longer be an excuse for the industrial executive who lays out his plant in a ridiculous fashion and fails in his developments because of a lack of appreciation of basic economic principles.

To some, perhaps, it is a pathetic sight to see the passing of old friends with their "rule-of-thumb" ideas, their so-called "chemical intuition" and their one-sided god, "experience"; but the world moves on, and order is slowly forming out of chaos. The young men of today are bringing this about, building on the solid foundation laid by the older regime.

Mr. Tyler starts his book with two interesting chapters on the characteristics and statistical position of the chemical engineering industries. Those who have worked long and hard to make the general public respect both the chemist and the chemical engineer will find plenty of ammunition in this discussion. In the third chapter, which is on chemical engineering projects, the writer brings out clearly the grim necessity for research and development; would that all boards of directors were required by law to read this brief comment. The next two chapters deal with plant location and layout. Many a company has "gone down for the third time" because of a lack of a common-sense viewpoint on these two important factors.

In the reviewer's opinion one of the high spots of the book is the chapter entitled, "Cost Accounting Principles." It is remarkable because of its thoroughness and because of the keen critical nature of the author's statements. Less than a week after the publication of this chapter the auditor of a certain chemical plant decided, with regret, not to submit for publication an excellent article on this same subject. At the same time the subject matter of a series of lectures given in the chemical engineering department of a certain university was changed to include much of Mr. Tyler's material.

The seventh chapter, "Unit Operation Costs," is without doubt the best in the book. No further statement will be made concerning it because the reviewer wishes the reader to have the pleasure of making his own discovery.

The eighth and tenth chapters hold interesting views on management, operation and control while the ninth deals with economic considerations in the utilization of fuels and energy. These chapters should prove fascinating instruction for students, chemical engineers and many industrial executives.

In short, Mr. Tyler's "Chemical Engineering Economics" gives us for the first time in book form a concise and useful analysis of the economic and business principles underlying our industries and our profession.

## Atmospheric Nitrogen Industry

THE ATMOSPHERIC NITROGEN INDUSTRY, WITH SPECIAL CONSIDERATION OF THE PRODUCTION OF AMMONIA AND NITRIC ACID. By Bruno Waeser. Translated by Ernest Fyleman, with a foreword by F. F. Crowley. In two volumes. P. Blakiston's Son & Co., Philadelphia. 746 pp. Price \$10.

Reviewed by B. F. Dodge

If one wished to know such facts about the nitrogen industry as the capitalization of a certain fixation plant in Galicia, how much ammonium sulphate was produced in Belgium in 1913, the cost of Chile saltpeter in Antwerp in June, 1915, the annual requirements of the Canary Islands for nitrogeous fertilizers, in what year the Yawatamachi Works in Japan started to manufacture byproduct coke, how much money the Uruguayan Government borrowed to erect experimental plants, who controls the carbide trade in Finland and a host of other facts and statistics, relevant and some irrelevant to the world nitrogen industry, he could certainly find it in Vol. I of Waeser's book, which has now been translated into English. This volume is devoted entirely to a review, from an economic standpoint, of the development of the atmospheric nitrogen industry in nearly every civilized country in the world. It should be a valuable reference work for one who is looking for statistics of this kind.

We are inclined, however, to be a bit skeptical as to the reliability of the heterogeneous mass of facts that are here collected together, after reading the chapter devoted to the developments in the United States. There one may learn many strange and interesting facts about the chemical industry in this country. Incidentally the references to sources of information would indicate that the great majority of his facts about the American industry was taken from German publications. It is apparent that the author has collected together, largely from German journals, a large number of facts, some probably authoritative, others of doubtful reputation, and some based purely on rumor, and has produced from these, with some semblance of arrangement, a book. The author has undoubtedly done the best that any one man could do for the magnitude of the task is appalling and could only be properly undertaken by the collaboration of a number of authorities.

The German edition covers developments up to 1921 only, and naturally great changes have occurred since then in an industry that is developing so rapidly. The English translation attempts to remedy this by the addition of a supplement at the end of each chapter, which is intended to cover the period 1921-24. These supplements are distinctly disappointing. They consist largely of an inadequate bibliography covering the period of 1921-24, and a few general statements which



are not of much value and often misleading. For example, the following three statements each constitute a separate paragraph in the supplement to the chapter in Vol. I dealing with the United States. "At Fort Worth there are six Linde plants which produce 850 cu.m. of 90 to 95 per cent helium daily at a very cheap rate." "The annual loss of helium in the United States is 500,000,000 cu.ft." "Technical research is organized on very large lines."

Volume II deals with the technical, as distinct from the economic, developments in the atmospheric nitrogen industry. There is a chapter devoted to each of the important nitrogen fixation processes such as the Haber-Bosch, the arc, the cyanamide, etc., and a chapter on the production of nitrogen and hydrogen and various chapters on some of the conversion processes such as the catalytic oxidation of ammonia to nitric acid. One who expects to obtain any actual first-hand data on any of the processes treated is bound to be disappointed as Waeser is mainly quoting the periodical and patent literature. Nevertheless the volume should prove useful to one who wishes to obtain an idea of the general features of the various processes and a general survey of the literature and patents concerned with each.

As in Vol. I, developments subsequent to 1921 are only treated in a sketchy fashion, mainly by references only, and since many significant changes have occurred since then, the volume is practically out-of-date as soon as published.

In the back of Vol. II there is a bibliography which lists the books that have been published on the atmospheric nitrogen industry and which gives a summary of the most important periodical literature from 1914-21. There is also a list of patents taken out in the leading countries, arranged in numerical order. The foreword to Vol. I, contributed by Mr. Crowley, is an excellent general review of the whole nitrogen problem and a few of the more recent developments not covered in the book itself are briefly mentioned.

In spite of its various limitations, the book is undoubtedly the best review we have of the nitrogen fixation industry and it is to be regretted that a little more effort was not spent in bringing it up to date.

### The New Heat Theorem

THE NEW HEAT THEOREM. By W. Nernst, translated from the Second German Edition by Guy Barr. E. P. Dutton and Company, New York. 277 pp. Price \$4.

Reviewed by George Granger Brown

This volume is apparently a perfect translation of Professor Nernst's treatise. For this perfection Dr. Barr deserves our gratitude, as many recent translations are not as satisfactory. The second (1924) German edition, from which the translation is made, is identical with the first (1917), except for the addition of 13 supplementary pages.

Nernst has assumed a familiarity with thermodynamics and has confined the discussion generally to the third law and its applications. The third law is referred to throughout the text as "my heat theorem" and the data reported are limited practically to the researches conducted by Nernst and his colleagues, perhaps "not entirely without justification," as Nernst himself points out. Although the volume would be more valuable if the more direct methods of the American

investigators had been included, the fact that Nernst can present a complete story based on results obtained in his own laboratories, up to ten years ago, is an indication of the importance of his work.

Nernst adheres to his assumption that the entropy of all gases, liquids and solutions, as well as crystalline solids, is zero at the absolute zero of temperature, but presents no data in support of this assumption. Recent work at the University of California indicates that the theorem may be limited to apply only to pure crystalline solids at the absolute zero. Because of this fact, direct evidence of the extension of the third law to include solutions and gases should be made available before this assumption of Nernst can be generally accepted.

A considerable part of the volume is devoted to empirical approximation formulas, chemical constants and their use in estimating equilibria and thermal data. Such calculations are of value in filling gaps in our knowledge of thermal properties, but because of their foundation on questionable assumptions, demand great skill in interpretation.

Although "thermodynamics is specially distinguished by its definite and precise conclusions," most writers on this subject, with the possible exception of Gibbs, occasionally lapse into vague or confusing statements or assumptions. Nernst is no exception. It seems unnecessary to use  $U$  and  $A$  for the total internal and free energy contents respectively, for two pages, if the same symbols are used to indicate finite changes in energy content thereafter. Although  $A$  and  $F$ , ( $A + PV$ ), are distinguished on p. 102, elsewhere this precision is not evident.

The data and discussion suggest the wide application of the third law, to the computation of free energies, equilibria, vapor pressure, electrochemical effects, etc., as well as to thermal data. The book is inspiring, as are all texts by this master and should be a valuable addition to any physical or chemical library.

### The How and Why of Arc Welding

ARC WELDING. Published by the Lincoln Electric Company, Cleveland, Ohio. 160 pp. Price \$1.50.

This book contains a fairly complete description of what can be done by the arc welding process and is profusely illustrated with photographs showing various types of work discussed. Among other points brought out, one of particular interest to the chemical equipment manufacturer is the possibilities that lie in the substitution of welded steel equipment for many of the machines or parts that have formerly been made of cast iron. Often steel will be found to serve as well as castings and the resulting saving in weight and cost for equal strength is an important item. A discussion is given of methods for redesigning cast iron parts for manufacture in steel and numerous examples are shown by illustrations.

Of interest to the chemical engineering industries is the substitution of welded tanks for riveted tanks. This is discussed and the comparative superiority of the welded joint is brought out. Welding of tanks and other steel equipment formerly riveted in construction are illustrated by many photographs. In addition to the above cited features, the volume contains much information on welding procedure, costs, speeds and strength of welds.

### The Practice of Lubrication

THE PRACTICE OF LUBRICATION. By T. C. Thomsen. McGraw-Hill Book Company, Inc., New York. 616 pp. Price \$6.

Reviewed by Gavin R. Taylor

This new edition is not a complete revision of the first edition, which was published six years ago, but it includes additional helpful data. The viscosities of typical oil are given in Redwood, Engler, and Centipoise, as well as Saybolt units, making the book more valuable to European engineers. A brief description of centrifugal purifiers and their application has been added.

Although based on European practice, this book is still one of the best dealing with the applications of lubricants. Some of the recent work on the theory of lubrication is mentioned briefly, but, as the author points out, any complete review of this subject would be handled best in a separate volume. This book should be of great value to lubricating engineers, electrical and mechanical engineers in charge of factories having lubrication problems, oil manufacturers and research chemists.

The next revision should include a description of high-pressure systems for the application of grease. The chapter on automobile lubrication might well be expanded. The section on transformer oils should be made more complete by a brief description of the principal sludge tests. The brief description of oil testing methods should also be revised, since all the methods are no longer standard.

### Applied X-Rays

APPLIED X-RAYS. By George L. Clark, assistant professor of applied chemical research in the Massachusetts Institute of Technology. McGraw-Hill Book Company, Inc., New York. 255 pp. Price \$4.

In "Applied X-Rays" Professor Clark has presented for the first time the science and technique of X-rays as pertaining to the work of the research chemist and engineer. Part I outlines the fundamental science of X-rays; Part II describes the direct effects and applications of X-rays; and Part III shows how X-rays can be used in the ultimate analysis of materials. Parts I and II are excellent critical surveys of the general literature and will provide the necessary grounding for the specialized technique of the structural studies, in which the author has proved himself to be an authority. Part III considers the following subjects: crystals and X-ray diffraction; the experimental methods of crystal analysis; crystal analysis of elements and inorganic compounds; crystal structures of carbon compounds; qualitative and quantitative analysis by X-rays; relations between structure and the fundamental properties of crystals; X-rays in the study of colloidal and amorphous structure; X-ray diffraction methods in metallurgy.

### Electro-Organic Chemistry

ELECTRO-ORGANIC CHEMISTRY. By C. J. Brockman, associate professor of chemistry, University of Georgia. John Wiley & Sons, Inc., New York. 381 pp. Price \$5.

"Electro-Organic Chemistry" is a critical review of anodic and cathodic reactions involving compounds of carbon. Under reactions at the anode are included: introduction to electrolytic oxidation; the oxidation of ionized substances; the oxidation of non-ionized substances; and substitution. Reactions at the cathode

include: introduction to electrolytic reduction; the reduction of aromatic nitro compounds; the reduction of nitroso compounds; the addition of hydrogen to unsaturated compounds; the reduction of the carbonyl group; the reduction of compounds containing arsenic, chlorine, sulphur, mercury. An inclusive working bibliography of the book and periodical literature greatly increases the usefulness of the volume, which organizes in a satisfactory way a field in which the data have been scattered.

### Metallographic Researches

METALLOGRAPHIC RESEARCHES. By Carl Benedicks, director of the Metallografiska Institutet, Stockholm, Sweden. McGraw-Hill Book Company, Inc., New York. 307 pp. Price \$4.

Reviewed by Frank J. G. Duck

A work of this kind, since it presents a series of researches on widely diversified phases of physical metallurgy, cannot be viewed as a textbook except, possibly, to supplement an advanced course in metallography. And considering it solely as a reference work for the metallurgist and research worker, certain of the chapters are bound to have more interest and appeal than others—depending upon the field of study and investigation in which the reader is particularly engaged. For instance, the chapters entitled "Some Improvements in High-Power Microscopy," "A Microchemical Etching Method for Metallography," and "Some Fundamental Factors for Obtaining Sharp Thermal Curves" are of interest to all metallographists. "Hardness in General and the Hardening of Carbon Steel, High-Speed Steel, and Other Alloys" and "A Rational Section for Hard-Rolled Material" will interest the practical producer of steel as well as the laboratorian. But such subjects, among others, as "Some Points of View on the Kinetic Constitution of Solid Matter" and "Homogeneous Thermoelectric and Electrothermal Effects" are of value principally to the advanced student and research worker to whom the work, as a whole, will undoubtedly furnish many new and valuable "leads."

The book is admirably written, illustrated and presented. The material it contains is an important and valuable contribution to the limited literature, available in book form, on a comparatively new field of scientific endeavor. Originally presented as a series of lectures before eighteen colleges, universities and technical societies in the United States during 1926, the book undoubtedly will be welcomed by those concerned with the advancement of scientific control in our metallurgical industries. The rapid post-war increase in such control apparently assures the work a wide circulation.

### A Welder's Guide

THE OXWELDER'S MANUAL. Instructions for Welding and Cutting by the Oxy-Acetylene Process. 9th Edition. Oxweld Acetylene Co., New York. 216 pp. Price \$1.

In putting forth this ninth edition of its manual of welding procedure, the publishers have completely rewritten the work, embodying in it the best modern practice. The preceding eight editions have filled a valuable place, instructing users of oxy-acetylene welding equipment in the proper technique in its use and serving largely as a text for instruction in welding. The new edition promises to serve even better for these purposes. It deals comprehensively with the welding of steel, iron, alloys and non-ferrous metals. It should be available to the maintenance departments of all industrial plants.



## Readers' Views and Comments

### An Open Forum

The editors invite discussion of articles and editorials or other topics of interest

#### Thermal Relations in a Scottish Oil Shale Retort

To the Editor of Chem. & Met.:

Sir—In my article published in your December, 1926 issue under the above head, and under the subhead "Heat transferred to the distilling shale by the steam and its reaction product, water gas," the summary of gases formed as I first wrote it, contained an error in addition. This should have read:

The yield of gases from the combined reactions (1) and (2) are:

	Per Ton of Shale		Per Pound of Shale	
	Volume	Weight	Volume	Weight
CO.....	2,260	166	1.130	0.0830
H <sub>2</sub> .....	5,274	28	2.637	0.0140
CO <sub>2</sub> .....	1,506	173	0.753	0.0865

The above will change the heat transferred by the H<sub>2</sub> to 53.5 B.t.u. per lb. of shale, the heat transferred by the CO<sub>2</sub> to 22.2 B.t.u. per lb. of shale, the heat transferred by the water gas to 98.9 B.t.u. per lb. of shale and the total heat transferred by the steam and the water gas then becomes 215.3 B.t.u. per lb. of shale. The heat thus transferred to the shale is therefore 52.1 per cent of total required. The increase in the amount of heat transferred to the shale by the water gas and the steam together over that transferred by the undecomposed steam is 85 per cent. The increase in the amount of heat transferred to the shale by the water gas and steam together over that which would be possible if no steam were converted to water gas becomes 18.8 per cent.

The gas formed by the water gas reaction will have the composition: CO<sub>2</sub> = 16.6 per cent; H<sub>2</sub> = 58.4 per cent; CO = 25.1 per cent. Its fuel value will be 270 B.t.u. per cu.ft.

The combined gas produced by the retort will have the composition: H<sub>2</sub>S = 0.25 per cent; CO<sub>2</sub> = 18.0 per cent; C<sub>2</sub>H<sub>6</sub> = 0.62 per cent; H<sub>2</sub> = 55.9 per cent; CO = 23.9 per cent; CH<sub>4</sub> = 0.87 per cent; C<sub>2</sub>H<sub>4</sub> = 0.77 per cent; N<sub>2</sub> = 0.22 per cent. The fuel value will be 303 B.t.u. per cu.ft.

Under the section "The Economics of the Water Gas Feature," the statement should be modified in accordance with the above change, to say:  $9,040 \times 270 = 2,440,800$  B.t.u., or per lb. of shale = 1,220 B.t.u. Therefore the heat consumed is 29.3 per cent of the heat of combustion of the gas formed.

Salt Lake City, Utah.

L. C. KARRICK,  
Consulting Engineer.

#### Should We Abolish Patent Trusts?

To the Editor of Chem. & Met.:

Sir—Commenting upon the article which appeared in the December issue of *Chem. & Met.* entitled "Should We Abolish Patent Trusts?" we offer the following:

It is generally conceded that research and industry are dependent upon each other and since mutual benefits are in sight, it would seem but fair that they strive to reciprocate and encourage good relationships. This reiterates a statement by Dr. Keyes in connection with his conception of the status of the research chemist.

However, Dr. Keyes sees calamity ahead if patent trusts should be abolished. We would like to carry this thought a bit further and analyze, if possible, the reaction which would follow such an abolishment. It would appear that aside from the disastrous effects brought out by Dr. Keyes, we would have other viewpoints before us which would have decidedly different aspects. We refer specifically to the vast stimulating effect which such an action would have upon research in plant control laboratories. The smaller man, or routine chemist, as we frequently hear him called, would be given a chance to enter his ideas in competition with those coming from the highly organized research laboratory. An idea is inherently an idea, whether it be originated in a university, in a control laboratory, a plant, or a research department. Such legitimate competition would tend to equalize conditions from the standpoint of those who are more directly concerned with the work of chemical invention than any others.

Why grant valueless patents? Dr. Keyes makes this statement in commenting upon Dr. Vaughan's work: "But he does not seem to realize that a very large percentage of the patents so far issued in the United States are of very little or no value, and that the few valuable patents which have been issued in this country are practically all in operation."

It would seem feasible to reduce the number of patents if the condition as set forth above exists—and we are in thorough accord with Dr. Keyes in this contention—and a fitting slogan to adopt here would be, "Quality not quantity is wanted." Such a procedure would have a two-fold effect; that is, a lot of time-consuming red tape which surrounds the issue of patents would be eliminated, because of the decreased demand made upon the time of the Patent Office in keeping track of "valueless patent" files, which would in turn speed up the time required for the worth-while inventions to get through the mill in marketable form. Both of these effects would encourage workers in the field and industry would profit thereby. Hence, the present system might be partially condemned on the ground that it does not encourage industry.

ELLIS W. COATES,  
Chief Chemist.

The Federal Products Co.,  
Cincinnati, Ohio.

#### Symposium on Pure Metals

To the Editor of Chem. & Met.:

Sir—Your report of the symposium on Pure Non-Ferrous Metals, p. 769, in the December, 1926, issue was rather misleading. I did not show any copper with a conductivity of 106 per cent—I wish I could. The conductivity of the large crystals of copper exhibited was 100.6 per cent.

In regard to the effect of impurities in copper, it is the metals which form solid solutions with copper which have a deleterious effect on the conductivity; metals which do not alloy with copper have but little effect upon the conductivity.

S. SKOWRONSKI.

Raritan Copper Works,  
Perth Amboy, N. J.

## Selections From Recent Literature

**New Blast Furnace Process.** P. W. Uhlmann, *Chemiker-Zeitung*, Jan. 15, pp. 37-8. From theoretical considerations (thermal relations), the new process of using gas for blast furnace reduction has some advantages over coke reduction and should be commercially successful. The most satisfactory gas is a water gas enriched with hydrogen to contain about 35 per cent CO and 65 per cent H<sub>2</sub>.

**Italian Leucite.** T. Thorssell, *Zeitschrift für angewandte Chemie*, Dec. 30, pp. 1593-7. Italy's rich deposits of leucite constitute an enormous potential source of Al and potash. Many processes of working up leucite ores have been proposed. Of these, several show promise of commercial success, e.g. the Norsk Hydro (acid) process; the lime treatment and other double decompositions; and sintering processes for utilizing leucite in cement making or the like.

**Pigment Spreading.** E. O. Rasser, *Kunststoffe*, Jan., pp. 2-4. As a spreading agent for pigments in paints, varnishes and like coatings, talc has several advantages. It is easy to grind extremely fine, insoluble in water and oils, proof against acids and alkalis, and relatively cheap. Within the limits to which the use of spreading agents must conform, it is a useful component of protective coatings, particularly of rustproofing paints. It is also valuable in compositions for frosting glass.

**Blast Furnace Reactions.** V. Falcke, *Zeitschrift für Elektrochemie*, Jan., pp. 1-11. In a study of the thermodynamics of blast furnace ore reduction, good agreement was found between theory and practice. Measurements at 750 to 1,000 deg. C. agreed with the calculated effects of heat of reaction (combustion of graphitic C and of CO) and specific heats of the substances involved. The equilibrium of CO with C and CO<sub>2</sub> was studied in particular. The literature of the subject is briefly reviewed.

**Chemical Equipment.** P. Shilling, *Chemiker-Zeitung*, Jan. 12, pp. 29-31. Descriptions, illustrated with diagrams, of modern designs for kettles, evaporators, stills, furnaces, lead chambers, towers and like equipment for use in the heavy chemical industry.

**Edible Oils.** T. Andrews, *Chemistry and Industry*, Dec. 24, pp. 970-5. Impurities commonly occurring in vegetable oils; modern practice in filtration, boiling, neutralizing, bleaching and deodorizing of natural or hydrogenated oils.

**Coking.** *Chemistry and Industry*, Dec. 17, pp. 953-4. The Woodall-Duckham continuous process of carbonization in vertical retorts is described and illustrated. The advantages are high gas yield, large gas output for ground space used, heat saving, low operating cost, improved operating conditions and good quality of domestic coke produced.

**Lacquer Equipment.** Erich Stock, *Kunststoffe*, Dec., pp. 243-6. The items

described and illustrated in this article are: (1) the Sommer filter press, operating at 1.5 atm. pressure, for clarifying varnishes and lacquers; and (2) the Sommer esterification apparatus, for making resin esters from rosin, the copals, etc., by treatment with glycerol.

**Sulphurous Acid.** Bernhard Neumann, *Zeitschrift für angewandte Chemie*, Dec. 16, pp. 1537-42. The patent literature on production of sulphur dioxide from gypsum is reviewed, to show that the use of promoters for the decomposition is general. On the basis of the thermal relations in the dissociation of CaSO<sub>4</sub>, the proposal is made that the process could be carried on without any expenditure of fuel by using blast furnace slag as the source of heat. Experiments indicate a 95 per cent recovery of the sulphur in the gypsum by this method. The Diehl process of recovering sulphur from slag is discussed.

**Activated Sludge.** F. Sierp, *Zeitschrift für angewandte Chemie*, Dec. 9, pp. 1521-34. A description, illustrated with photographs and diagrams, of the sewage treating and clarifying plant of the city of Essen. The processes, and the results obtained with respect to NH<sub>3</sub> and N content, O content and O requirement, putrescence and turbidity are discussed in the light of American and European practice.

**Carbon Tetrachloride as Denaturant.** C. Stellbaum, *Chemiker-Zeitung*, Dec. 1, pp. 905-6. Carbon tetrachloride is unsuitable as a denaturant; even in the official (German) formula with 1.5 per cent it reacts with the water in the alcohol and forms corrosive substances which soon damage iron containers and render the alcohol unfit for chemical uses.

**Grinding and Sifting Lime.** Ernst Blau, *Chemiker-Zeitung*, Nov. 24, pp. 886-8. Illustrated description of modern plant and equipment for grinding, air separation and sifting in lime production.

**Celluloid Hollow Articles.** A. Bahls, *Chemiker-Zeitung*, Nov. 24, pp. 889-90. Illustrated description of the formation of celluloid toys and the like by blowing softened celluloid to shape with steam.

**Electrodeposition of Metals.** Fritz Foerster, *Zeitschrift für Elektrochemie*, Nov., pp. 525-34. A study of the influence of current density, ion concentrations, physical conditions and presence of foreign ions on the form in which metals are deposited from solution. Suitable conditions for the electrolytic refining of tin are described. Illustrated with photographs of crystalline, granular and smooth deposits.

**Electric Firing.** Richard Lepsius, *Zeitschrift für Elektrochemie*, Nov., pp. 543-6. A new process of firing explosives, by which any desired number of successive charges may be set off at intervals of a half second or multiples thereof after the electrical contact is made. The first (instantaneous) fir-

ing cartridge has no retarder; the succeeding cartridges have retarders of increasing length according to the desired intervals. Illustrated.

**Hydraulic Vulcanizers.** F. W. Koerver, *Kautschuk*, Nov., pp. 273-4. Illustrated description of hydraulic hot plate presses for curing belting and like goods. The relative merits of the frame and column constructions are discussed.

**Cottonseed Crushing.** *Journal of Oil and Fat Industries*, Dec., pp. 415-8. Illustrated description of a model plant recently built at Garland, Texas.

**Electrolytic Polarization.** Samuel Glasstone, *Journal of the Chemical Society*, Nov., pp. 2887-902. A study of the deposition potentials of Fe, Co and Ni. This potential is independent of the pH and of the anions present and apparently is not affected by depolarizers. It varies with the temperature and, in the case of mixtures of two or all three of the metal ions, it varies according to the proportions of each metal present.

**Aromatic Amines.** E. Briner, A. Ferrero and H. Paillard, *Helvetica Chimica Acta*, Dec., pp. 956-8. Toluidines are produced by catalytic dehydration of cresols in presence of NH<sub>3</sub>; diamines are similarly made from dihydroxy compounds such as resorcin. A suitable catalyst is Al<sub>2</sub>O<sub>3</sub>.

**Magnesia Cements.** W. Feitknecht, *Helvetica Chimica Acta*, Dec., pp. 1018-49. A detailed study of factors governing the physical and chemical changes in the formation and setting of the Mg oxychloride cements.

**Molding Celluloid.** A. Bahls, *Kunststoffe*, Dec., pp. 239-40. Illustrated description of the process of making hollow articles, such as soap dishes, of molded celluloid. A recent innovation is the application of steam or hot water pressure, a modification of the blowing process.

**Cellulose lacquers.** Leit, *Kunststoffe*, Dec., pp. 241-2. A review of recent advances, as recorded in the German patent literature.

**Lacquer Making Equipment.** Erich Stock, *Kunststoffe*, Dec., pp. 243-6. Illustrated description of a pressure filter and a new esterifier unit (Sommer design).

**Products from Coal.** Georges Patart, *Chimie et Industrie*, Nov., pp. 713-29. An illustrated description of modern practice in low-temperature carbonization and the utilization of gaseous products. Particular attention is given to the production of synthetic methanol and formaldehyde and the alcohols, ketones and other higher aliphatic compounds.

**Mild Steel.** Eugene Perot, *Comptes rendus*, Dec. 6, pp. 1108-10. A discussion of the use of cyanogen and of cyanamide for cementite formation, as compared with ethylene and methane. Cyanogen, without renewing the atmosphere, gives results about equivalent to those obtained with ethylene or methane in continuous circulation.

**Alumina from Clays.** Heinrich Kessler, *Chemiker-Zeitung*, Dec. 4, p. 917. A short account of Czecho-Slovak Patent No. 18,648, granted to Lederer and Stanczak for a process for recover-



ing Al from kaolin and other clays. The yield is said to be nearly quantitative, and it is predicted that the process will make Al refining independent of bauxite.

**Pumps.** J. Watson, *Industrial Chemist*, Dec., pp. 553-6. Pumps for nitric and other acids; stoneware force pumps; steam and boiler pumps; turbine pumps. Illustrated.

**Corrosion by Lubricating Oil.** W. Singleton, *Industrial Chemist*, Dec., pp. 540-9. Effect of water, alkali and other impurities in small amounts on the corrosion of steel by oils; corrosion in the pure oils. The results are derived from a great many immersion tests. Illustrated with photomicrographs.

**Drying.** W. Graulich, *Chemiker-Zeitung*, Dec. 8, pp. 921-2. A comparison of the thermal efficiency of two different constructions of driers. An installation for direct utilization of the heat of combustion gases gave a relatively high efficiency.

**Hydrogen.** J. Bronn, *Chemiker-Zeitung*, Dec. 8, pp. 922-3. A review of recent advances in the commercial production of hydrogen gas. Among the industries producing hydrogen which might be recovered for making synthetic ammonia, byproduct coke is listed.

**Potassium Nitrate.** F. Frowein and E. von Muehlendahl, *Zeitschrift für angewandte Chemie*, Dec. 2, pp. 1488-500. The double-ternary system ( $K_2/Mg/Na_2$ ) ( $(NO_3)_2/Cl_2$ ) furnishes the theoretical basis for various large scale methods for producing  $KNO_3$ . The physical-chemical relations are discussed in detail and illustrated with tables and curves.

**Pumping Gases.** S. G. M. Ure, *Industrial Chemist*, Dec., pp. 521-4. Illustrated description of fans, rotary blowers, and compressors (rotary, reciprocating and centrifugal). Equipment for corrosive and dangerous gases is discussed.

**Nobel Explosives Plant.** *Industrial Chemist*, Dec., pp. 525-32. Illustrated description of processes and equipment in use at the Ardeer factory of the Nobel Co. The processes include manufacture of sulphuric and nitric acids and refining of glycerol.

**Paint Grinding.** S. P. Schotz, *Industrial Chemist*, Dec., pp. 535-9. Mechanical and chemical aids in grinding; use of colloid mills; fineness of pigments; disk, stone and edge runner mills; disintegrators and air separators. Illustrated.

**New Evaporator.** *Industrial Chemist*, Dec., pp. 550-2. Illustrated description of the Vogelbusch evaporator, a new high-effect, rapid-flow design.

**Artificial Leather.** M. De Wilmet, *Revue generale des matieres plastiques*, Nov., pp. 691ff. A review of the materials and methods of manufacture of the three types of artificial leather: (1) from leather scrap, (2) from cellulose derivatives, and (3) from rubber.

**Calcium Cyanide.** H. H. Franck and C. Freitag, *Zeitschrift für angewandte Chemie*, Nov. 25, pp. 1430-2. Pure calcium cyanide has been made for the first time. It was obtained from its

diammoniate, which is formed by double decomposition of Ca salts (preferably the nitrate) with cyanides in liquid ammonia, or by action of Ca metal on ammonium cyanide in liquid ammonia.

**Refractories.** Hans Hirsch, *Zeitschrift für angewandte Chemie*, Nov. 25, pp. 1437-43. Problems of the refractories industry which require the attention of chemists are utilization of new materials (oxides of Zr, Th, Cr, etc.); the physical chemistry of ceramic processes; testing; and various problems connected with the utilization of different forms of silica. Illustrated.

**Fermentation Activators.** Hans Fringsheim, *Zeitschrift für angewandte Chemie*, Nov. 25, pp. 1454-7. It has been found that the amylolytic enzymes have a complementary ferment which activates the later stages of starch fermentation, but does not function until the saccharification has proceeded to about 75 per cent maltose. There is promise of much future progress in the application of activated fermentation to alcohol production.

**Soap.** E. L. Lederer, *Zeitschrift für angewandte Chemie*, Nov. 18, pp. 1393-7. A review, with literature citations, of recent advances in the science and technology of soap making.

**Sodium Sulphide.** Peter P. Budnikoff, *Zeitschrift für angewandte Chemie*, Nov. 18, pp. 1398-402. A study of the optimum conditions (sulphate-carbon ratio, time of fusion, effect of foreign substances, influence of different gases) in the reduction of sodium sulphate. High temperature reduction is not practical; a catalyst is needed.

**Synthetic Fuel.** Alfred W. Nash, *Journal of the Society of Chemical Industry*, Nov. 26, pp. 876-8. A review of recent developments in the catalytic hydrogenation of CO with production of liquid hydrocarbons suitable for fuel. It is doubtful if the products could compete on a cost basis with present motor fuels.

### Government Publications

Prices indicated are charged by the Superintendent of Documents, Washington, D. C., for pamphlets. Send cash or money order; stamps and personal checks not accepted. when no price is indicated, pamphlet is free and should be ordered from Bureau responsible for issue.

**German Chemical Developments in 1926,** by William T. Daugherty. Bureau of Foreign and Domestic Commerce, Trade Information Bulletin 451. Price 10 cents.

**Relations Between Quality of Water and Industrial Development in the United States,** by W. D. Collins. Geological Survey, Water-Supply Paper 559. 15 cents.

**Wool By-Products and Wool Wastes.** Tariff Information Surveys FL-40. 10 cents.

**Methanol—Report of the U. S. Tariff Commission to the President of the United States.** 10 cents.

**Transportation Costs and Costs of Production.** Report of U. S. Tariff Commission. 15 cents.

**Simplified Practice Recommendations**

of the Department of Commerce on: Asphalt (First Revision); Paint and Varnish Brushes; Steel Spiral Rods (for concrete reinforcement); Classification of Iron and Steel Scrap; Tinware, Galvanized and Japanned Ware. 5 cents each, except classification of Iron and Steel Scrap, which is 10 cents.

**Relations Between Rotatory Power and Structure in the Sugar Group,** Part I, by C. S. Hudson. Bureau of Standards, Scientific Paper 533. 35 cents.

**Radiometric Measurements on the Carbon Arc and Other Light Sources Used in Phototherapy,** by W. W. Coblenz, M. J. Dorcas and C. W. Hughes. Bureau of Standards, Scientific Paper 539. 15 cents.

**A Review of the Literature Relating to the Critical Constants of Various Gases,** by S. F. Pickering. Bureau of Standards, Scientific Paper 541. 15 cents.

**Recent Developments in Lamp Life-Testing Equipment and Methods,** by J. F. Skogland and R. P. Teele, Jr. Bureau of Standards, Technologic Paper 325. 15 cents.

**Research on the Production of Currency Paper in the Bureau of Standards Experimental Paper Mill,** by Merle B. Shaw and George W. Bickling. Bureau of Standards, Technologic Paper 329. 10 cents.

**High Silicon Structural Steel,** by H. W. Gillett. Bureau of Standards, Technologic Paper 331. 15 cents.

**Static Hysteresis in the Flexure of Bars,** by G. H. Keulegan. Bureau of Standards, Technologic Paper 332. 10 cents.

**Magnetic Testing.** Bureau of Standards, Circular No. 17 (Fourth Edition). 15 cents.

**Testing of Thermometers.** Bureau of Standards, Circular No. 8 (Fourth Edition). 10 cents.

**U. S. Government Master Specifications on the following materials issued under Bureau of Standards Circular Numbers indicated:** Turpentine (Gum Spirits of Turpentine and Steam-Distilled Wood Turpentine), No. 86 (3d edition); Varnish, Spar, Water-Resisting No. 103; Soap, Cake, and Grit, No. 130 (2d edition); Cheese-cloth, unbleached, No. 258 (2d edition); Refractories, Fire Clay, Plastic, No. 297 (2d edition); Clay, Fire, No. 298 (2d edition); Brick, Fire-Clay, No. 299 (2d edition); Matting, Rubber, for use around electrical apparatus or circuits not exceeding 3,000 volts to ground, No. 312; Ash, Soda, No. 314; Soda, Caustic (Lye) (for cleaning purposes), No. 345; Soda, Laundry (Washing Soda), No. 316; Sodium Carbonate, Granular (Monohydrate Crystals), No. 317. 5 cents each.

**Dust Respirators,** by S. H. Katz, G. W. Smith and E. G. Meiter. Bureau of Mines, Technical Paper 394. 15 cents.

**Low-Temperature Carbonization of Coal,** by A. C. Fieldner. Bureau of Mines, Technical Paper 396. 15 cents.

**Composition of Materials from Various Elevations in an Iron Blast Furnace,** by S. P. Kinney. Bureau of Mines, Technical Paper 397. 5 cents.

**Recovery of Molybdenite from the Ore,** by H. A. Doerner. Bureau of Mines, Technical Paper 399. 5 cents.

# The Plant Notebook

## An Exchange for Operating Men

### Maple Balls in Pebble Mill Used As a Mixer

By Edward W. Lawler  
Metuchen, N. J.

Several months ago I was in a plant where my attention was attracted by a pebble mill working in an unusual fashion for a mill of that type. First I heard the pebbles roll, then slide and not roll. Next the pebbles dropped instead of rolling. Previous experience with these mills caused me to ask how it was possible and why it was necessary to make a mill perform in this way. The answer was emphatic: "We're not trying to make the mill perform. We're about through with it. If it hadn't cost so much, we'd throw it out now!"

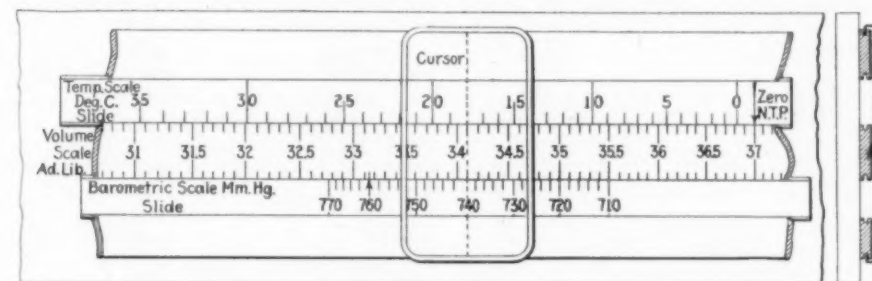
Prior to the installation of this mill for use as a mixer, this plant had used a paddle mixer. One of the ingredients was very fine and was inclined to ball up without mixing. A burrstone was used to rub out these balls. The capacity of the mixer was small so that the pebble mill seemed better from that point of view also.

The pebble mill used was 6 ft. in diameter and 8 ft. long. It was unlined to avoid the possibility of contamination from chipping of the lining. Instead of solving the difficulties, this mill produced new ones. One of the ingredients used was of an unctuous nature, one was fine and likely to ball, while a third was a highly volatile liquid. The fine material was a pigment. If the mill was run long enough to mix this, the mass became heated and the volatile constituent was lost. But if the pigment was not thoroughly mixed, each batch had a different shade. Also, there was danger that small balls of the pigment would cause streaks when the mixture was used.

The mill could not be loaded any higher than 12 in. below the center. This allowed a mass of material to build up on the heads. Sometimes this mass would be almost 5 in. thick and when the charge was dumped, it might drop into the mixed material. The inside of the mill had become polished and the mass would slip, causing some of the peculiar noise which had attracted my attention to the trouble.

To keep this mass from sliding on the shell, it was suggested that bars be attached; but this would have resulted in broken flint in the product. Various sizes of pebbles, pebble loads and material loads were tried, but the charge continued to slip, heat the mass and make a satisfactory product impossible. The mill was considered a complete and noisy failure.

I had on hand a small mill, 30 x 22



Double Slide Rule for Gas Calculations

in., lined with rubber. In a test with this mill, a charge was prepared of small maplewood balls, equivalent to one-half the volume of the mill, and material equivalent to one-fourth this volume. The mill, with this charge, was run for a definite number of revolutions.

Repeated tests gave the same quality product. No balling, no heating and no loss of volatile was encountered. In addition, there was no noise to speak of.

The large mill was then charged in the same way, with successful results. This mill is now mixing at least 500 lb. more per charge. It is loaded to the center, preventing unmixed material from adhering to the heads. There is no slipping of the load. No pebble chips are found in the finished product. In short, an expensive failure has been turned into a success.

### Slide Rule For Routine Gas Testing

By Paul Mathews  
Philadelphia, Pa.

There are certain instances where it may be necessary to make frequent calculations of volumes of gas for comparative or testing purposes. A mechanical method of performing these calculations may prove of interest.

The method outlined below was evolved to meet the needs of carbide manufacture, where samples of each batch of carbide run from the furnace are routine tested for gas yield, and it is necessary to perform the calculations indicated very frequently, say three or four times an hour, for a twenty-four hour day.

In order to fix the problem let us consider the physical conditions of the above particular case. The testing consists substantially in mixing a weighed quantity of carbide with excess of water, the acetylene gas formed being collected with due precautions against loss, over water, in a gasometer of the usual type, fitted with a U-tube of mercury whereby the internal pressure

may be equalized with that of the atmosphere; also a thermometer whose bulb is immersed in the gas. The apparatus also comprises a pointer reading on a scale of volume.

The tester observes the thermometer, the barometer, and the volume of gas, after leveling the mercury in the U-tube so that the barometer tells him the actual pressure in the container. Such procedure will be familiar to all who have been trained to any extent in laboratory methods.

In order to make comparisons it is necessary to reduce the volume so obtained to normal temperature and pressure, viz: 0 deg. C. and 760 mm., and further to make allowance for the presence of water vapor in the gasometer. (Gas dissolved in the water of the gasometer is usually neglected as the water soon becomes saturated.)

This involves the application of the laws of Charles and Boyle by means of the following formula:

$$\frac{V_o}{V} = \frac{273}{273 + t} \cdot \frac{P - p}{P_o} \quad (1)$$

where

$V$  = observed volume (any units).

$P$  = observed atmospheric pressure in mm. Hg.

$t$  = observed temperature in deg. C.

$P_o$  = normal pressure = 760 mm.

$p$  = vapor tension of water in mm. Hg as given in Regnault's tables.

$V_o$  is the volume at normal pressure and temperature to be found.

This last quantity enters as a correction of the observed atmospheric pressure to compensate for the tendency of water to vaporize and fill up space which would, under perfectly dry conditions of equal pressure be occupied by the gas (acetylene in this instance), and is therefore a positive increasing function of the temperature, as given in Regnault's tables, which are reproduced for the normal temperature range to the nearest mm. in column 2 of the table.

The standard normal pressure and temperature is, of course, taken to be under perfectly dry conditions.

While the above formula (1) does not lend itself readily to logarithmic or slide rule computation, a closely approximate result may be obtained in this way from the following considerations. We may write the equation (1):



$$V_0 = V \cdot \frac{273}{273+t} \cdot \frac{P}{P_0} \left(1 - \frac{p}{P}\right) \quad (2)$$

which may be written

$$[\log V_0 - \log V] = [\log P - \log P_0] + \left[ \log \left( \frac{1 - \frac{p}{P}}{\frac{273}{273+t}} \right) + \log 273 \right] \quad (3)$$

From this we can readily construct logarithmic volume and pressure scales of the usual type adapted for setting off the first two square bracket terms, and solving logarithmically the Boyle portion of the equation, viz:  $\frac{V_0}{V} = \frac{P}{P_0}$ .

We may also construct for the last square bracket term a scale of temperatures provided we neglect the variation of  $P$  in this term that is to say we write  $P_0$  for  $P$  in this term and make a log scale of  $\log \frac{P_0 - p}{273 + t}$  in place of  $\log \frac{P - p}{273 - t}$ , inserting the values of  $p$  from column 2 of the table. This term is a function of the temperature only.

In order to have an arrangement suitable for operation by non-mathematical personnel the scales were set as indicated in the figure, the volume scale being fixed and increasing from left to right, and the temperature and pressure scales being slides increasing from right to left and left to right respectively. Various arrangements are possible, but by arranging a cursor to span the three scales thus arranged it was possible for the following simple directions to be given and followed:

1. Set red mark on upper scale to point on middle scale corresponding to observed volume.
2. Slide cursor over point on upper scale corresponding to observed temperature.
3. Slide bottom scale till observed barometer reading is under cursor line.
4. Read volume over blue mark on lower scale.

The marks mentioned are indicated on the figure by arrows, and correspond on the pressure scale to 760 mm., and on the temp scale to 273 abs.,

Table Giving Data for Construction of Slide Rule

Temp. Deg. C.	Vap. Tens. m.m. Hg.	$P_0 - p$	$\log (P_0 - p)$	$\log (273 + t)$	$\log \frac{P_0 - p}{273 + t}$
0	5	755	779	361	+418
1	5	755	779	377	+402
2	5	755	779	393	+386
3	6	754	773	409	+364
4	6	754	773	424	+349
5	7	753	767	440	+327
6	7	753	767	456	+311
7	7	753	767	471	+296
8	8	752	762	487	+275
9	9	751	756	502	+254
10	9	751	756	517	+239
11	10	750	750	533	+217
12	10	750	750	548	+202
13	11	749	744	563	+181
14	12	748	739	578	+161
15	13	747	733	593	+141
16	14	746	727	608	+119
17	14	746	727	623	+104
18	15	745	721	638	+83
19	16	744	715	653	+62
20	17	743	709	668	+41
21	18	742	704	683	+21
22	20	740	692	698	-6
23	21	739	686	712	-26
24	22	738	680	727	-47
25	23	737	674	742	-68
26	25	735	662	756	-94
27	27	733	651	771	-120
28	28	732	645	785	-140
29	30	730	633	800	-167
30	32	728	621	814	-193
31	35	727	615	828	-213
32	35	725	603	842	-239
33	37	723	591	857	-266
34	40	720	573	871	-292
35	42	718	561	885	-324

(0 deg. C.), under dry conditions i.e., scale, that is to say, 29 units in the direction of decreasing temperature.

Care must be taken after ruling the scales to place them in correct directional relation to each other, and to place the numbers on them so as to read the right way up. Any joiner will make tongued and grooved slides, while the cursor can be made from three-ply wood. A cruder, but surprisingly accurate rule may be made from cardboard.

The maximum inherent error over barometric range down to 710 mm. and temperature range up to 35 deg. C. is approximately 0.42 per cent.

## Welded Joints in a Pipe Still

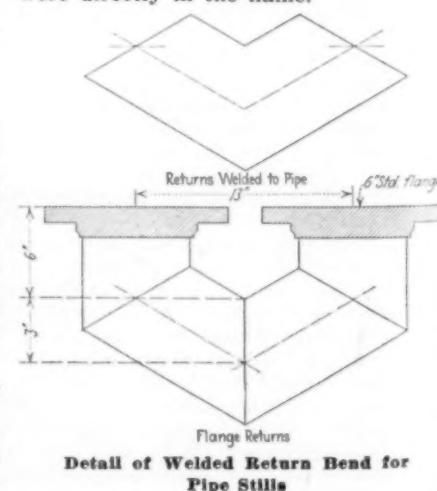
By Tom Gilpin  
Ponca City, Okla.

Each of the pipe stills in which we have used welded joints, contains 150 joints of 6-in. pipe, made up in fifteen sections of ten joints each. Pipes in each section are spaced 13 in. on centers, horizontally, and sections are spaced 12 in. on centers vertically, pipe in adjoining sections being staggered.

Nine of the sections were made up in the shop, with flanges screwed on and then welded to prevent any possible leak in the threads. The pipe for the other six sections was placed in the brickwork during the construction of the furnace and the return bends were made in the shop, then placed on the pipe and welded. The accompanying sketch shows the details of the return bend.

That part of the sections where the flanges are welded to the return bends is exposed more to the heat and must therefore be more often replaced. The return bends are not directly exposed to the flame, but are on the outside of the furnace, and when replacement of a pipe is necessary where the return bend is welded to the pipe, the pipe is unflanged in several places and steamed out thoroughly, after which a little steam is left in the pipe while the work of cutting and welding is being done.

Recently a gasket blew out of a flange and let the hot oil run down onto the welded return bends. This oil burned for twenty minutes but did not damage the return bends, although they were directly in the flame.



Previous to the adoption of this method, so far as the author is aware, only a Cartesian table was available with temperatures along one axis and pressures along the other, and the volume of one litre of gas reduced to normal conditions as co-ordinate points, it being necessary to multiply one such specific volume by the observed volume for each test. The extra time taken and liability to error were of course, considerable.

The illustration shows the rule in position for the following calculation: The readings were: Volume = 37 (litres), temperature = 18 deg. C., barometer = 740 mm. The arrow on the top or temperature scale is therefore set on point 37 on the volume scale; the cursor slid over point 18 on the temperature scale; point 740 on the bottom scale is then slid under the cursor line, and the corrected volume read over the arrow on the bottom scale, the quantity being 33.13 litres.

The errors of such a rule would not be objectionable in a great many cases, and are within the accuracy of the apparatus employed in the example given. Further, such accuracy can easily be obtained on the rule without meticulous care in ruling. In our case, the rule was made some three feet long with large and easily read figures.

The actual construction of the rule is simple, the volume and pressure scales being merely a large edition of an ordinary slide rule, any desired range being selected for the volume.

The temperature scale may be made from the following considerations as indicated in the table. The first two columns give temperatures in degrees C. and corresponding values of  $p$  to nearest mm. from Regnault's tables.

The third column gives  $P_0 - p$  (760 -  $p$ ). The fourth column gives  $\log P_0 - p$  (omitting the first digit). The fifth column gives  $\log 273 + t$ , and the sixth the difference of columns 4 and 5, that is to say, a difference table for

$$\log \frac{P_0 - p}{273 + t}$$

The last column may be set out to the selected scale, the total length being indicated by the algebraic difference between the extremities, i.e.: 742 units. Since it is only differences with which we are concerned neither characteristics, nor the first digit of the logs are taken account of. The arrow or standard zero mark may be set off from the wet zero as obtained above by

$$\text{a distance: } \log \frac{P_0 - p_0}{P_0} \text{ where } p_0 \text{ is the}$$

vapor tension of water at 0 deg. C., i.e.: 5 mm. from col. 2. This is equal to -29 units if 742 units is the whole

## Equipment News

*From Maker and User*

### Threader Cutter

The Borden Co., Warren, Ohio, has recently brought out a new "Beaver" adjustable die stock series called the No. 70 series. These stocks are designed for use with power drives. The dies may be quickly thrown open after the thread is cut, thus avoiding backing off by hand. They are available in plain and ratchet styles for pipes of  $\frac{1}{4}$  to 2 in. in diam.

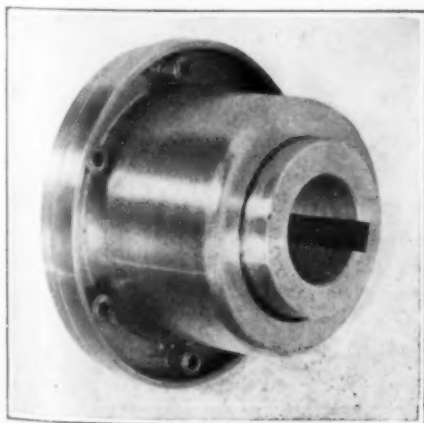
### Small Pump

A new pump has been added to the line of small pumps manufactured by Dunning Pump & Manufacturing Co., Philadelphia, Pa. This pump is of the two cylinder type, with a 3 in. bore and a 3 in. stroke. It is particularly designed for use with mechanical refrigerating systems and for operations of that type. It is totally enclosed with a crank case containing the oil which is sent to the internal parts by a splash system. The cylinders are vertical and the pump is driven through a shaft from a motor or other driving unit.

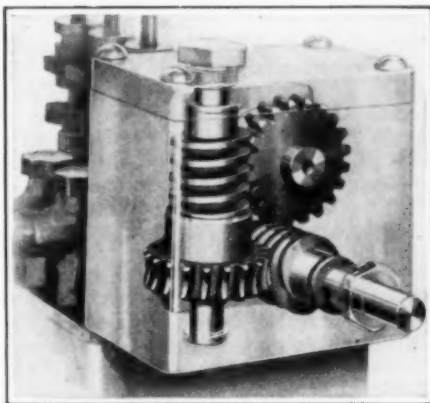
### Flexible Coupling

The Falk Corporation, Milwaukee, Wis., has recently placed on the market a new design of flexible coupling, as shown in the accompanying photograph. This coupling consists of a tempered steel spring in segments, two flanged steel disks with slots into which the spring fits and a steel shell which serves to protect the parts from dirt, acts as a fastener for the spring and as a container for lubricant.

This coupling is of all steel construction and is so made that the shafts can be disconnected without disturbing either machine. Aligning is simple and can be done with only a short straight edge and an ordinary set of feelers. Standard sizes are available rated from  $\frac{1}{2}$  to 20,000 hp. at 100 r.p.m.



Falk Flexible Coupling



Double Worm Speed Reducer for Fractional Horsepower Drives

### Speed Reducers

A line of fractional horsepower speed reducers, a phantom view of one of which accompanies this article, has recently been brought out by Hills-McCanna Co., 2025 Elston Ave., Chicago, Ill. This line of reducers is available in 20 to 1 and 30 to 1 single reductions, and 50 to 1; 100 to 1; 200 to 1 and 400 to 1 double reductions in grease-tight boxes, 4x2 $\frac{1}{2}$ x4 in. in dimensions. Hardened steel worms and bronze gears of standard design are used, running continuously in transmission oil or grease. All moving parts are protected against leakage by stuffing boxes. The reducers are adaptable for use with motors up to 1 hp. The makers particularly recommend this reducer where vertical reductions are necessary, on account of the grease-tight case.

### Refractory Cement

General Refractories Co., Philadelphia, Pa., recently placed on the market a new high temperature cement. The basic component of this cement is chromite. It contains no sodium silicate or other quick-setting elements. The natural atmospheric quick-set has been intentionally retarded sufficiently to permit easy troweling without frequent addition of water. The cement is said, however to have a reasonably quick and strong cold set, to set hard and uniformly and to maintain a constant bond through all temperatures. The fusion point is over 3,500 deg. F. and the tensile strength over 300 lb.

The cement is of neutral character and, in metallurgical work, has a resistance to acid as well as basic slags. It is claimed to give good service in boiler settings and similar furnaces where coal and ash slags form. In ceramic kilns and similar equipment it is said to give efficient protection to the brickwork from erosion by gases.

### Gas Cutting Torch

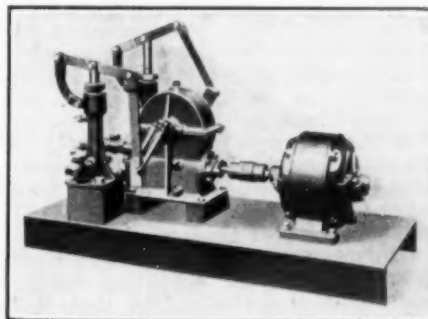
The Alexander Milburn Co., Baltimore, Md., have placed on the market a gas cutting torch for use with illuminating and byproduct gases. Because this torch uses a cheap fuel, it is said to reduce the cost of cutting metal materially. The torch is provided with a super-heater which heats and expands the oxygen, raising its temperature to approximately 100 deg. C., prior to combustion. This increases the temperature of the gases at the torch tip, increases the rate of flame propagation in the burning mixture, and reduces the oxygen consumption somewhat. This super-heater, which operates on the principle of the bunsen burner, burns a portion of the illuminating fuel and heats the oxygen as it passes through a series of copper coils.

It is claimed that the use of this heated and expanded oxygen, in conjunction with illuminating gas, gives a better penetration into the metal, a narrower kerf and sharp clean edges, speedy and smooth cutting with a notable absence of metallic slag on the underside of the cut. It is also claimed that it does not caseharden the surfaces of the cut, leaving them in practically the same state as the original metal before the cutting was accomplished.

### Proportioning Pump

Hills-McCanna Co., 2025 Elston Ave., Chicago, Ill., have developed a pump for proportioning the delivery of chemicals into process. This device is shown in the accompanying photograph.

The pump is of the single plunger type with ball valves and packed stuffing box and, it is claimed, is a highly efficient metering device. Various sizes, types of drive and materials of construction are available to meet the demands of differing applications. It is claimed that the use of this design of proportioning pump enables a closer control to be maintained in the process where used.



Proportioning Pump for the Delivery of Chemicals to Processes



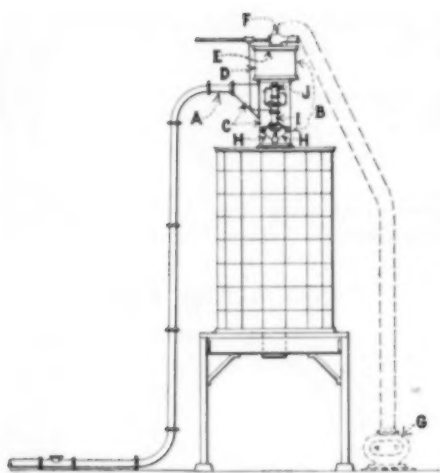


Fig. 1—An Outline Drawing of Pneumatic Conveyor and Operating Head

## Pneumatic Conveyor

A new design of pneumatic conveyor called the "AroCarrier" has recently been brought out by the Conveyors Corporation of America, 326 W. Madison St., Chicago, Ill. This device is particularly designed to handle bulk materials of a granular nature which possess characteristics making it readily possible to feed them by gravity into an opening in a pipe line.

Referring to Figs. 1 and 2, the design of the conveyor is as follows: A is a pipe line of desired length in which is located the intake opening or openings into which the material is charged. This pipe terminates in the operating head, B, which is divided into two zones, the accumulator zone and the suction zone respectively. At the lower section of the head, designated as C on the drawing, is the accumulator zone, while the upper section, D, is the suction zone. The top of the operating head, E, is connected to an exhaustor of the steam jet type or to a motor driven rotary exhaustor, shown at F and G respectively. The accumulator zone is equipped with two gates, marked H.

In operation a vacuum is created in the suction of the operating head by means of the exhaustor. The gates at H are closed and the only point through which air can be drawn to replace that exhausted is through the pipe line through which a high velocity air current is established of sufficient volume to carry the material. The material accumulates in the accumulator at C, to a predetermined weight for which adjustment can be made. When it has reached this weight a release of the gates is effected by means of the hydraulic control device marked I which opens the gates and allows the material to be discharged into any desired container. When the material has been completely discharged, the gates automatically close and the operating head is sealed air tight by means of the cylinder marked J.

The period of time required for accumulation is dependent on the capacity for which the operating head is built and also the weight that it is desired to accumulate before discharging. Adjustment can be made for any weight desired, the standard size of

head holding up to 1,000 lb., while special sizes are available for greater amounts. The time of opening the discharge gates, discharging the material and restoring the accumulator head to its original air-tight condition, takes approximately 1½ seconds.

The makers of this conveyor claim that it can be used for many types of materials. Operating tests have demonstrated its adaptability for handling sized coal, ashes from stokers, ashes from combustion chambers, and ashes from pulverized fuel burners. In addition grain and materials of a like granular nature have been successfully handled. Ordinarily the equipment is made of steel but where chemicals of a corrosive nature are to be handled, the manufacturer is prepared to furnish the equipment in any material best suited to withstand the corrosive action.

It is claimed that there is no dust discharged from this equipment because of the design of the suction zone of the operating head. This zone is so built as to catch the dust inside and discharge it with the main body of the material from the accumulator.

Since the operation of the conveyor discharge is dependent on the weight accumulated, which is a predetermined amount, the conveyor acts as an automatic weighing or checking device of the materials passing through it. A counter on the discharge gates, giving

a record of the number of discharges in a given time, will be readily translated into weight.

The equipment is furnished in standard sizes having discharges ranging from 5 to 50 tons per hour. Capacities in excess of 50 tons can be furnished to meet special requirement. When operating with a steam jet exhaustor, costs for steam have been worked out through tests at between 4 and 5 cents per ton of material handled. The manufacturers claim that the attainment of these costs are not unusual and that the device provides a low-operating-cost conveyor, of which the installation cost compares favorably with that of any other type of conveyor. Maintenance costs are also low.

## Portable CO<sub>2</sub> Meter

The Bacharach Industrial Instrument Co., Pittsburgh, Pa., has developed a portable CO<sub>2</sub> meter operating on the same principle as their permanently installed CO<sub>2</sub> meter of the electric type previously described in these columns. This instrument is 14½ lb. in weight, and the outside dimensions of the case are 6½x7½x9 in. The guaranteed accuracy is ½ of 1 per cent CO<sub>2</sub>. It can be used for continuous indications for short periods of two to three hours as well as for ordinary portable test uses.

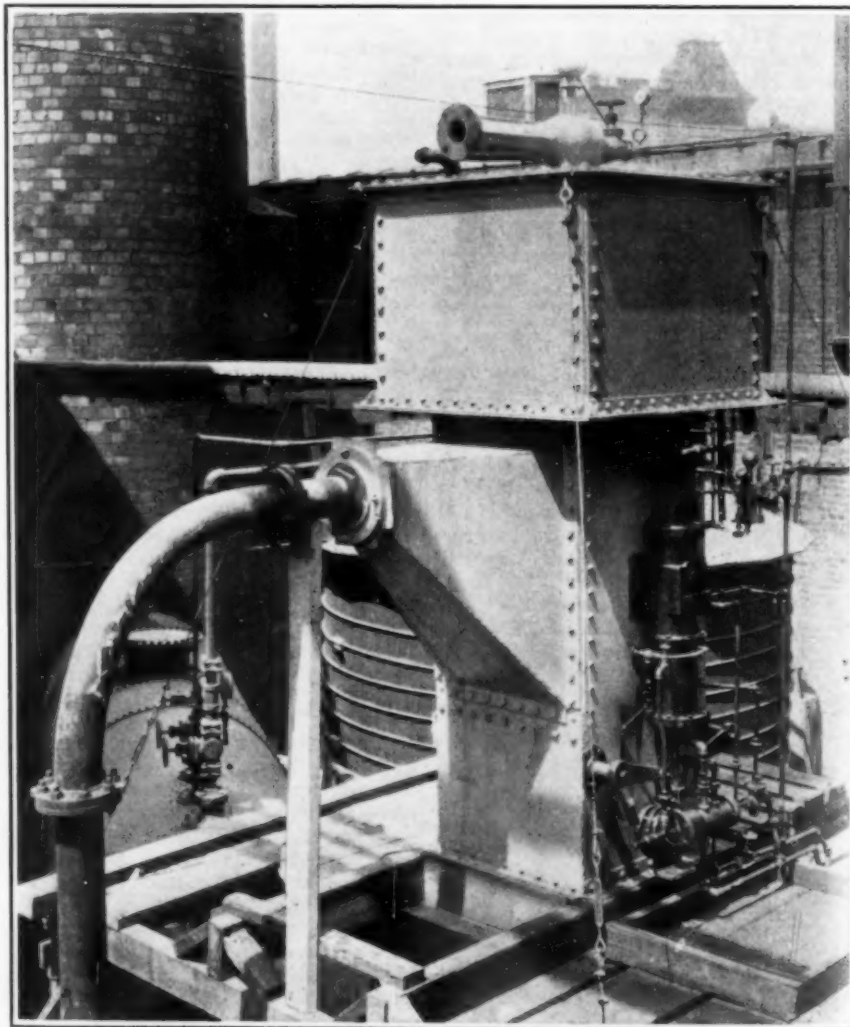


Fig. 2—View of Operating Head of Pneumatic Conveyor Showing Steam Jet Exhauster on Top and Hydraulic Feed Operating Device at the Side

## Pipe Cutter

Oster Mfg. Co., Cleveland, Ohio, has recently brought out an improved pipe cutter of the Saunders type. This cutter is designed to give a strong cutting tool that will "track" readily when turned by a mechanical drive, as, for instance, when connected to a power-driven pipe threader. The new cutter can also be operated by hand.

Increased cutting-off speed is said to be secured because of the deeper bite made possible by special reinforcement of the cutter where the greatest strain occurs. The cutter is made in two sizes, one for pipe from  $\frac{1}{2}$  to 1 in. in dia., and the other for  $\frac{1}{2}$  to 2 in. diam. pipe.

## Platinum Substitute

An alloy metal suitable for use as a substitute for platinum has been placed on the market recently by the Palo Co., 153 W. 23d St., New York, N. Y. This metal, called "Palorium," is an alloy of gold with metals of the platinum group. It is a white alloy, in appearance almost identical with platinum. Hardness and tensile strength compare favorably with platinum, as does also the temperature coefficient. It may be sealed in glass and used effectively. When heated it retains its original stiffness and does not soften as platinum does, which is said to offer considerable advantage in plant and laboratory use. It is malleable, ductile and homogeneous, melting at 1,310 deg. C.

Tests conducted with this alloy heated by gas flame in crucibles of 16.0635 grams, in contact with reagents, duplicating actual working conditions, gave results in comparison with platinum as given below:

Reagent	Time-hours	Losses in milligrams	
		Platinum	Palorium
Conc. HCl...	3	0.5	5.3
Ignition...	2	0.5	0.9
Na <sub>2</sub> CO <sub>3</sub> fusion...	5	0.1	2.6
NH <sub>4</sub> OH...	2	0.0	0.2*
KHSO <sub>4</sub> ...	3	2.2	26.7
KOH 40 percent	2	0.2	0.4
K <sub>2</sub> S.....	2	0.0	0.2
Conc. H <sub>2</sub> SO <sub>4</sub>	2	13.0	0.7
Dil. HNO <sub>3</sub> ...	2	1.4	29.7
Conc. HNO <sub>3</sub>	3	0.1	16.9
KOH fusion	2	2,379.2†	23.0

\*Gain.  
†Crucible failed.

Since the time of tests varied from 2 to 5 hours and the crucible was filled to capacity each time, the alloy was subjected to harder usage than ordinarily encountered. Resistance to potassium hydroxide fusion and to concentrated sulphuric acid was superior to platinum and in other cases the losses were sufficiently close to make it a possible substitute.

Further tests showed very small losses for periods under one hour. For instance, loss in weight after 40 minutes with conc. HCl was 0.9 milligrams and for one hour was 1.0 milligrams.

The metal may be used in electrolytic determinations but only as a cathode. It is obtainable as cathodes, crucibles, dishes, sheet, wire, contact points and various other commercial forms. Its cost is approximately 45 per cent less than that of platinum.

## Manufacturers' Latest Publications

W. H. Nicholson & Co., Wilkes-Barre, Pa.—Bulletin No. 1026—A bulletin describing the construction and use of the new flexible coupling introduced recently by this company.

Coppus Engineering Corp., Worcester, Mass.—Bulletin 120—A bulletin describing "Vano" blowers for high-temperature gases at about 1,000 deg. F.

La Motte Chemical Products Co., Baltimore, Md.—A new bulletin giving a clear description of the colorimetric determination of hydrogen ion concentration and water analysis by means of the material and equipment made by this company.

Bristol Co., Waterbury, Conn.—Bulletin No. 348—A bulletin describing the model 479 pyrometer controller.

B. F. Sturtevant Co., Hyde Park, Boston, Mass.—Catalog No. 291—A bulletin describing the equipment for and installation of pneumatic collecting and conveying systems for dusts and other finely divided solid materials.

The American Rolling Mill Co., Middletown, Ohio.—A booklet entitled "Iron Economy in Industry" dealing with the use of the metal products made by this concern in corrosion-resisting service.

Automatic & Electric Furnaces, Ltd., 173 Farrington Road, London, E. C. 1, England.—Catalog describing and illustrating electric furnaces for use at temperatures up to 1,400 deg. C.

Ingersoll-Rand Co., 11 Bway., New York, N. Y.—Bulletin No. 7095—A bulletin describing "Cameron" single stage, double suction, volute, centrifugal pumps.

Bethlehem Steel Co., Bethlehem, Pa.—Catalog K.—A general catalog of mine and industrial track equipment and related steel products.

Eimer & Amend, 18th St. and Third Ave., New York, N. Y.—A number of new leaflets dealing with laboratory equipment such as electric ovens, filter paper, special lighting devices, water stills, portable mixers, colorimeters for hydrogen ion determination, pressure reducing valves for compressed gases, laboratory porcelain, laboratory clocks and viscosimeters.

DeLisle Engineering Corporation, Buffalo, N. Y.—A leaflet describing a protective coating of emulsified asphalt known as "Delkote."

Patterson Foundry & Machine Co., East Liverpool, Ohio.—A new catalog of standard sizes of pebble, ball and tube mills.

Universal Vibrating Screen Co., Racine, Wis.—Catalog No. 70—Catalog of type C mechanical vibrating screens.

Quigley Furnace Specialties Co., 26 Cortlandt St., New York, N. Y.—A booklet entitled "Protect Your Plant and Equipment," dealing with "Triple A" solutions for protecting metal, concrete, wood and other surfaces from corrosion.

Deister Concentrator Co., Fort Wayne, Ind.—A new booklet describing the Leahy "No-blind" vibrating screen.

Flynn & Emrick Co., Baltimore, Md.—A new booklet describing the Huber stoker.

General Electric Co., Schenectady, N. Y.—New bulletins as follows: GEA-451, describing "MT" control systems for direct current motors; GEA-527, describing sectional drive, regulator type, for paper machines; GEA-528, describing small multi-stage centrifugal air compressors; GEA-544, describing dynamometers; GEA-548, describing pedestal bases for vertical motors; GEA-555, describing electric elevator equipment in the Alabama Power Company's building in Birmingham, Ala.; GEA-556, describing automatic electrode feeding device, magnetic clutch type, welding head and control; GEA-559, describing electric elevator equipment in the Bar Association Building, New York City; GEA-569, describing constant potential arc welding sets; GEA-570, describing hand starting compensators, for squirrel cage induction motors, of the dead front cabinet type; GEA-578, describing type D mechanical drive turbines.

Esterline-Angus Co., Indianapolis, Ind.—Bulletin 1126—A bulletin describing improvements in graphic instruments made by this company including a new direct current meter element, an improvement in the scale plate and an addition to the Quick Trip line.

Steere Engineering Co., Detroit, Mich.—Pamphlet No. 288—A bulletin describing charging machines for automatically and continuously fueling water gas generators.

Hardinge Co., York, Pa.—A new bulletin giving illustrations of the various uses for Hardinge grinders.

W. H. Nicholson & Co., Wilkes-Barre, Pa.—Bulletin No. 127—Bulletin describing

three and four way valves for air, steam or water at pressures up to 500 pounds.

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.—A bulletin entitled "The Engineering Achievements of the Westinghouse Electric & Mfg. Company for the Year 1926," by H. W. Cope, of that company.

Abbé Engineering Co., 30 Church St., New York City—Bulletin No. 23—A bulletin of pulverizing, grinding and mixing machinery made by this company.

The Denver Fire Clay Co., Denver, Colo.—A folder describing assay furnace muffles made of Carbofrax.

Alexander Milburn Co., Baltimore, Md.—Catalog No. 172E—A new catalog of welding and cutting apparatus made by this company.

Brown Instrument Co., Philadelphia, Pa.—Catalog No. 20—A new catalog describing the Brown electric flowmeter and illustrating various types of applications for which it is adapted.

Struthers Wells Co., Warren, Pa.—A catalog describing and illustrating the various types of riveted and welded steel plate construction which this company has made, including various types of chemical engineering equipment.

Hills-McCanna Co., 2025 Elston Ave., Chicago, Ill.—A new catalog describing power plant equipment and chemical proportioning pumps made by this company.

New Departure Mfg. Co., Bristol, Conn.—A folder giving some of the advantages of ball bearings as applied to electric motors.

Century Electric Co., St. Louis, Mo.—A new folder describing motors for use with oil burners, house pumps and mechanical refrigerating systems.

Botfield Refractories Co., Philadelphia, Pa.—A bulletin giving reprints of letters from users of "Adamant" fire brick.

Republic Flowmeters Co., 2240 Diversey Parkway, Chicago, Ill.—A folder contrasting the flowmeters of 17 years ago with those of today as made by this company.

General Insulating & Mfg. Co., Alexandria, Ind.—Catalog describing "Gimco," a heat insulator made of rock wool.

International Nickel Co., 67 Wall St., New York City—Nickel Steel Bulletin No. 9—A bulletin giving the physical properties of nickel and nickel chromium steels, being one of the series of data and application bulletins on nickel steel issued by this company.

American Blower Co., Detroit, Mich.—Bulletin 2004—A bulletin describing type "SE" steel plate blower. Also Bulletin 8001, a general catalog of "Sirocco" fans and blowers.

The Warner Elevator Mfg. Co., Cincinnati, Ohio—A bulletin of elevator specifications for the use of architects and engineers.

Ajax Electrothermic Corporation, Trenton, N. J.—A new folder dealing with steel melting by means of high frequency induction furnaces.

Federal Pneumatic Systems, Inc., 127 North Dearborn St., Chicago, Ill.—Bulletin No. 5—A bulletin describing air separators for dust collecting and exhaust systems.

A catalog describing the uses and production of feldspar, issued jointly by Golding Sons Company, Erwin Feldspar Company and Clinchfield Products Corporation.

La Mont Corporation, 200 Fifth Ave., New York City—A catalog of steam generators, primarily of the waste heat type.

Adam Hilger, Ltd., 24 Rochester Place, London, N. W. 1, England—A new catalog of polarimeters marketed by this concern.

Cleveland Crane & Engineering Co., Wickliffe, Ohio—A new folder illustrating the use of the Cleveland "Tramrail" system of handling material.

Sheet Steel Trade Extension Committee, 715 Oliver Building, Pittsburgh, Pa.—A new folder containing standard specifications for the fabrication and setting of sheet steel cornices.

W. F. Rockwell Co., 50 Church St., New York City—Bulletin No. 276—A new bulletin describing the revolving retort type of electric furnaces made by this company.

General Refractories Co., Philadelphia, Pa.—A bulletin describing the properties and use of "Grefco," a high temperature refractory cement.

American Mond Nickel Co., Clearfield, Pa.—A new bulletin on the properties and uses of Mond "70" alloy nickel.

C. J. Tagliabue Mfg. Co., 18 33d St., Brooklyn, N. Y.—Catalog No. 905C—A general catalog of recording thermometers, dial indicating thermometers, recording hydrometers, recording psychrometers, time operation recorders, vacuum and pressure recorders and controlling recorders. Also Bulletin No. 932, announcing a new simplified automatic gas analysis indicator and recorder.



## Patents Issued Jan. 4 to 25, 1927

### Paper, Pulp and Sugar

Paper and Process of Coating the Same. Gerhardt E. Grimm, Springfield, Mass., assignor to Westfield River Paper Company, Russell, Mass.—1,614,611.

Apparatus for Making Paper Pulp. William S. Lowe, Chicago, Ill.—1,613,839.

Paper Drier. Charles W. Shartle and Adam E. Bridge, Middletown, Ohio, assignors to The Shartle Brothers Machine Company, Middletown, Ohio.—1,614,694.

Method of Utilizing Waste Sulphite Cellulose Lye. Carl Gustav Schwalbe, Eberswalde, Germany.—1,615,102.

Composition of Matter Derived from Black Liquor and Process of Dealing With the Same. Lester C. Conner, Malden, Mass., assignor to Alfred S. Williams, Boston, Mass., and John T. Collins, Sandwich, Mass., trustees.—1,614,025.

### Rubber and Synthetic Plastics

Sponge-Rubber Product and Process of Making the Same. William Beach Pratt, Wellesley, Mass., assignor to Research, Incorporated, Boston, Mass.—1,614,019.

Method of Treating Balatas and Gutta-Perchas. Claude H. Smith, Akron, Ohio, assignor to The Goodyear Tire & Rubber Company, Akron, Ohio.—1,614,541.

Treatment of Cellulose. Fredrich Olsen, Dover, N. J., and Henry A. Aaronson, New York, N. Y.—1,615,343.

Manufacture of Filaments and Films from Viscose. William Mendel, Beverly, N. J., assignor to Samuel A. Neidich, Edgewater Park, N. J.—1,614,431.

Article Made from Plastic Material and Method of Making the Same. Richard T. Griffiths, Akron, Ohio, assignor to The Miller Rubber Company, Akron, Ohio.—1,613,993.

Process for Manufacturing Plastic Compositions and Products Obtained Thereby. Iwan Ostromislensky, New York, N. Y., assignor to The Naugatuck Chemical Company, Naugatuck, Conn.—1,613,673.

Method of Making a Phenolic Resin Varnish. Louis M. Rossi, Perth Amboy, N. J., assignor to Bakelite Corporation, New York, N. Y.—1,613,724.

### Petroleum Refining

Continuous Distillation of Oils. Frank A. Howard and Nathaniel E. Loomis, Elizabeth, N. J., assignors to Standard Development Company.—1,613,754.

Cracking of Hydrocarbon Oils. Charles Lester Parmelee, West Orange, N. J., assignor to Sinclair Refining Company, Chicago, Ill.—1,613,718.

Method of Cracking Oil. Frank E. Wellman, Kansas City, Kans., assignor to The Kansas City Gasoline Company, Kansas City, Kans.—1,615,779.

Oil-Cracking Still. Eugene C. Herthel, East Chicago, Ind., assignor to Sinclair Refining Company, Chicago, Ill.—1,615,583.

Apparatus for the Distillation of Hydrocarbon Oils. Max G. Paulus and Oswald C. Brewster, Casper, Wyo., assignors to Standard Oil Company, Whiting, Ind., and Chicago, Ill.—1,615,400.

Oil-Distillation Apparatus. Foster Malle Poole, Tulsa, Okla., assignor to The Brown Instrument Company, Philadelphia, Pa.—1,615,479.

Art of Pyrogenetic Conversion of Hydrocarbon Oils. Frank A. Howard, Elizabeth, N. J.; Edgar M. Clark, New York, N. Y.; and James R. Carringer, Elizabeth, N. J., assignors to Standard Development Company.—1,615,384.

Process of Cracking or Treating Oils and Other Similar Hydrocarbons. Homer T. Darlington, West Chester, Pa., and Ralph M. Steffen, Lincoln, Neb., assignors to Martin B. Schuster, trustee, Joliet, Ill.—1,614,660.

Process for Cracking or Converting Oils. Otto F. Amend, New York, N. Y.—1,613,735.

Oil Still. John Primrose, Dongan Hills, N. Y., assignor to Power Specialty Company, New York, N. Y.—1,614,689.

Hydrocarbon Fuel and Process of Making Same. Lester Kirschbraun, Chicago, Ill.—1,614,559.

Distillation or Evaporation of Liquids. John Lewis Major, London, and Benjamin Taylor, Bilston, England.—1,614,483.

Continuous Distillation of Crude Petroleum Oils. Francis M. Rogers, Whiting, Ind., and Robert E. Wilson, Chicago, Ill., assignors to Standard Oil Company, Whiting, Ind., and Chicago, Ill.—1,615,407.

Motor Fuel and Process of Making Same. Lester Kirschbraun, Chicago, Ill.—1,614,735.

Producing Residual Oil Products. Edward E. Bartels, Whiting, Ind., assignor to Standard Oil Company, Whiting, Ind.—1,613,737.

Fuel-Distilling Apparatus. Frank E. Hobson, Bellingham, Wash.—1,614,028.

Art of Preparing Pitches. Francis M. Rogers and Oscar E. Bransky, Whiting, Ind., assignors to Standard Oil Company, Whiting, Ind.—1,613,723.

Fluid-Heater Control. Foster Malle Poole, Tulsa, Okla., assignor to The Brown Instrument Company, Philadelphia, Pa.—1,615,478.

### Organic Processes

Azo Dyestuffs and Process of Making Same. Hermann Wagner, Werner Langbein, and Karl Beck, Hochst-on-the-Main, and Karl Thiess, Sindlingen, near Hochst-on-the-Main, Germany, assignors, by mesne assignments, to Grasselli Dyestuff Corporation, New York, N. Y.—1,613,919.

Tetrakisazo Dyes and the Process of Manufacture. Joseph B. Oesch, Milwaukee, Wis., assignor to The Newport Company, Carrollville, Wis.—1,615,551.

Process of Manufacturing Dyes. Walther Penecke, Graz, Austria, assignor to Felice Beusa, Genoa, Italy.—1,615,646.

Trisazo Dyestuff and the Process of Manufacture. Joseph B. Oesch, Milwaukee, Wis., assignor to The Newport Company, Carrollville, Wis.—1,615,550.

Hydroxy-Benzanthrones and Process of Making Same. Karl Schirmacher, Karl Zahn, and Karl Wilke, Hochst-on-the-Main, and Paul Ochwat, Bad-Soden, Germany, assignors, by mesne assignments, to Grasselli Dyestuff Corporation, New York, N. Y.—1,614,398.

Condensation Product of Ketones and Phenols. August Amann and Ewald Fönrobert, Wiesbaden, Germany, assignors to the Firm Chemische Fabriken Dr. Kurt Albert G. m. b. H., Amoneburg, near Biebrich-on-the-Rhine, Germany.—1,614,172.

Process for the Manufacture of Esters of Oxy-Acids. Alfred Häussler, Nieder-Ingelheim-on-the-Rhine, Germany, assignor to the Firm of C. H. Boehringer & Sohn, Chemische Fabrik, Nieder-Ingelheim-on-the-Rhine, Germany.—1,614,195.

Method of Making Condensation Products from Mono- and Dicyclic Phenols and Aldehydes. August Amann and Ewald Fönrobert, Wiesbaden, Germany, assignors to the Firm Chemische Fabriken Dr. Kurt Albert G. m. b. H., Amoneburg, near Biebrich-on-the-Rhine, Germany.—1,614,171.

Manufacture of Carbon Disulphide. Philipp Siedler, Griesheim-on-the-Main, Germany, assignor to I. G. Farbenindustrie Aktiengesellschaft, Frankfurt-on-the-Main, Germany.—1,615,659.

Process of Preparing Nitro Amino Benzoyl O-Benzoyl Acid and Its Derivatives. Roger Adams and James Meyer Davidson, Urbana, Ill., and Ivan Gubelmann, South Milwaukee, Wis., assignors to The Newport Company, Carrollville, Wis.—1,614,584.

Manufacture of Iron Carbonyl. Martin Müller-Cunrad, Ludwigshafen-on-the-Rhine, Germany, assignor to I. G. Farbenindustrie Aktiengesellschaft, Frankfurt-on-the-Main, Germany.—1,614,625.

Method of Obtaining Colored Polymerized Styrol and Its Homologues and Products Obtained Thereby. Iwan Ostromislensky, New York, assignor to The Naugatuck Chemical Company, Naugatuck, Conn.—1,613,674.

Processes of Making Ethylene Glycol Monoalkyl Ethers. Joseph G. Davidson, Pittsburgh, Pa., assignor to Carbide & Carbon Chemicals Corporation.—1,614,883.

Process and Apparatus for Treatment of Gas Containing Carbon Monoxide. Walter H. Kniskern, Syracuse, N. Y., assignor to Atmospheric Nitrogen Corporation, Solvay, N. Y.—1,614,072.

Process of Preparing Urea.—Job Morten August Stilesen, Niagara Falls, N. Y.—1,614,698.

Process of Making a Nitrogenous Fertilizer Material. Guy H. Buchanan, Westfield, and Palmer W. Griffith, Elizabeth, N. J., assignors to American Cyanamid Company, New York, N. Y.—1,614,521.

Synthesis of Ammonia by Hyperpressures. Georges Claude, Paris, France, assignor, by mesne assignments, to Lazote Inc.—1,615,535.

Noncorrosive Alcohol Composition. Walter T. Schreiber, Baltimore, Md., assignor to U. S. Industrial Alcohol Co.—1,613,808.

Process of Producing Heavy Metal Cyanides. Kenneth F. Cooper, Great Neck, N. Y., assignor to American Cyanamid Company, New York.—1,614,523.

Process for Evolution of Hydrocyanic Acid from Cyanides. Hans Lebecke, Frankfurt-on-the-Main, Germany, assignor to The Roessler & Hasslacher Chemical Company, New York, N. Y.—1,615,637.

Method of Making Organic Peroxides. Ralph H. McKee, New York, N. Y.—1,614,037.

Process for the Manufacture of Decolorizing Carbons from Vegetable Materials. Oscar L. Barnebey, Detroit, Mich.—1,614,913.

Process for Producing Carbon Black from Natural Gas. Edward B. Parsons and William D. Inskeep, San Francisco, Calif., and William Hunt, Baltimore, Md.—1,614,685.

Process of Making Adsorbent Carbon. Oscar L. Barnebey, Columbus, and Merritt B. Cheney, deceased, late of Briggsdale, Ohio, by Josephine B. Cheney, administratrix, Briggsdale, Ohio.—1,614,707.

### Chemical Engineering Equipment and Processes

Still and Process of Distilling. Francis I. du Pont, Wilmington, Del., assignor to Delaware Chemical Engineering Company, Wilmington, Del.—1,609,349.

Gyratory Crusher. Harvey S. Anderson, Waterville, Ohio.—1,609,594.

Pulverizing Apparatus. Wister C. Williams, Decatur, Ill., assignor to McLaughlin Coal Reduction Company, Decatur, Ill.—1,610,345.

Apparatus for Pulverizing Material. Joseph E. Kennedy, New York, N. Y.—1,609,298.

Separator. Thomas J. Sturtevant, Wellesley, Mass., assignor to Sturtevant Mill Company, Boston, Mass.—1,611,254.

Separator. Thomas J. Sturtevant, Wellesley, Mass., assignor to Sturtevant Mill Company, Boston, Mass.—1,611,255.

Separation of the Constituents of Gaseous Mixtures. Claude C. Van Nuys, Cranford, N. J., assignor to Air Reduction Company, Incorporated, New York, N. Y.—1,612,164.

Liquefaction and Rectification of Gases. Claude C. Van Nuys, New York, N. Y., assignor to Air Reduction Company, Inc.—1,609,450.

Process of Concentrating Ores by Flotation. Harold Walter Elley, Wilmington, Del., assignor to E. I. du Pont de Nemours & Company, Wilmington, Del.—1,610,217.

Process for the Separation of One or More Constituents of Liquid Mixtures. Walter Bader, Spondon, near Derby, England, assignor to American Cellulose and Chemical Manufacturing Company Limited.—1,609,393.

Process of Purifying Gases. James B. Garner, Rolla, W. Miller, and George A. Shaner, Pittsburgh, Pa., assignors to Standard Development Company.—1,609,872.

Method of Manufacturing Highly-Active Carbon. Edouard Urbain, Paris, France, assignor to Urbain Corporation.—1,610,399.

Process of Regenerating Zeolites. Emil G. Duden, Oakmont, Pa., assignor to Wm. B. Scaife & Sons Company, Oakmont, Pa.—1,611,422.

Process and Apparatus for Making Glass. Harry F. Hitner, Pittsburgh, Pa., assignor to Pittsburgh Plate Glass Company.—1,610,376.

Process of Treating Zinc Waste. John Nevin Pomeroy, Philadelphia, Pa.—1,609,882.

Insecticide and Process for Preparing the Same. Wilhelm Schmitz, Berlin, Germany, assignor to The Tinoan Company of America, Inc., New York, N. Y.—1,610,167.

Oil-Solvent Process. Jacob Ehrlich, Belleville, N. J.—1,610,270.

Method of Prevention of Dust Explosions and Fires in Mills and Elevators. Lewis Andrew Stinson, Oak Park, Ill.—1,612,072.

Comminuted Wood Product and Method of Making the Same. William W. Christman, Ridgefield Park, N. J., assignor of one-third to C. C. Hines, Washington, D. C.—1,612,098.

Manufacture of Milk Powder. Jose Manuel Sierra, Southall, England.—1,609,384.

Pectin Product and Process of Producing Same. Eloise Jameson, Corona, Calif., assignor to California Fruit Growers Exchange, Los Angeles, Calif.—1,611,528.

Method and Apparatus for Counteracting Scaling and Corrosion. Henry Jermain Creighton, Swathmore, Pa., assignor to Anti-scale Corporation, Philadelphia, Pa.—1,611,853.

Process for the Production of Gelatin and Glue from Chrome Leather or its Shavings. Jakob Rinck, Neu-Erlaa, near Vienna, Austria.—1,612,746.

Purification of Wool Fat. Stanley Fowler, Yorkshire, and Edwin Edser, London, England.—1,610,854.

# News of the Industry

## Grasselli Loses Accelerator Patent Suit

In a decision handed down in the United States District Court, Southern District of New York, Jan. 24, 1927, Judge Augustus N. Hand declared the claims in the rubber accelerator suit of The Grasselli Chemical Company against the National Aniline & Chemical Company, Inc. invalid for lack of invention and granted a decree dismissing the bill with costs.

Suit was brought for alleged infringement of U. S. Patent No. 1,149,580 granted to F. Hofmann and K. Gottlob and relating to the acceleration of rubber vulcanization by an ammonium compound having a dissociation constant greater than  $1 \times 10^{-3}$  and having a basic reaction at the vulcanization temperature. The defendant was charged with infringement by sales of diphenylguanidine and triphenylguanidine to rubber manufacturers with the knowledge and intent that these chemicals would be used to accelerate the vulcanization of rubber. In the opinion Judge Hand states in part: "The situation is that the patentee who pretends to offer a chemical formula in respect to ammonium compounds which practical men may follow in securing accelerators useful in the vulcanization of rubber leaves the trade in a state of hopeless confusion. Only two of the substances specifically named, to wit: para-phenylenediamine and benzylamide are agreed upon by the parties as having the prescribed constant of dissociation. Two of the substances, to wit, naphthylamine and hexamethylenetetramine have constants admittedly less than  $1 \times 10^{-3}$ . Various aromatic diamines do not fall within the range. The constant of benzaldehyde ammonia cannot be calculated with any certainty; the constant of sodium amide is also uncertain, and that of the remaining substances particularly specified seems to be in dispute.

"In such circumstances, how does the man who wishes to follow the instruction of the patent secure any clear or profitable teaching? The claims call for a certain dissociation constant, but the specification, after stating that improved results similar to those realized by the teaching of the prior art can be obtained by the use of other bases having a dissociation constant greater than  $1 \times 10^{-3}$ , then goes on to name a number of illustrative substances, some of which do not have the constant, in others of which the constant is doubtful, and only two of which indubitably have it.

"The facts as presented and analyzed

convince me that the claims in issue attempting as they do to cover an enormous class of substances are based upon no experimentation with ammonium compounds sufficient to justify me in upholding them; furthermore that there is enough in the record to show not only that the broad claims covering in terms the future manufacture and use of substances not specifically named in the patent are without foundation but are negated by proof that the classification of accelerators attempted in these claims is neither correct nor useful. In addition to this, substances and processes of the prior art having all their characteristics completely identical with these broad claims leave the patentees with little more than a theory on which to found their patent rights.

"I hold the claims in suit invalid for lack of invention and grant a decree dismissing the bill with costs."

**Chemical & Metallurgical Engineering** is the successor to *Metallurgical & Chemical Engineering*, which, in turn, was a consolidation of *Electrochemical & Metallurgical Industry* and *Iron & Steel Magazine* effected in July, 1906.

The magazine was originally founded as *Electrochemical Industry*, in September, 1902, and was published monthly under the editorial direction of Dr. E. F. Roeber. It continued under that title until January, 1905, when it was changed to *Electrochemical & Metallurgical Industry*. In July, 1906, the consolidation was made with *Iron & Steel Magazine*, that had been founded 8 years previously by Dr. Albert Sauveur. In January, 1910, the title was changed to *Metallurgical & Chemical Engineering*, and semi-monthly publication was begun Sept. 1, 1915. On July 1, 1918, the present title was assumed and weekly publication was begun Oct. 1, 1919. Monthly publication was resumed in March, 1925.

Dr. E. F. Roeber was editor of the paper from the time it was founded until his death on Oct. 17, 1917. After a brief interim he was succeeded by H. C. Parmelee.

The staff of *Chemical & Metallurgical Engineering* comprises: H. C. Parmelee, editor; S. D. Kirkpatrick, associate editor; G. L. Montgomery, Chaplin Tyler, R. S. McBride and Paul D. V. Manning, assistant editors; H. M. Batters, market editor.

## Research Laboratory Endorsed By Pulp and Paper Men

At the annual meeting of the Canadian Pulp and Paper Association, held in Montreal, January 27, unanimous approval was given to the proposal to erect and endow a research laboratory at McGill University, at a cost of \$350,000. Quarters for scientific research in the interests of the Canadian Pulp and Paper industry, for the department of industrial and cellulose chemistry of the university, the pulp and paper division of the Forest Products Laboratories, and headquarters for the Canadian Pulp and Paper Association, will be provided by the new building. Among the problems of the industry awaiting solution, which will be taken up in the new laboratory, are: Reducing the degradation of cellulose in the cooking processes, by which it will be possible to increase the present yield of 50 per cent in the newsprint industry to 60 or 65 per cent with a higher resultant quality of product; recovery of many wasting byproducts in sulphite liquor; utilization of woods now regarded as waste; changing of the colloidal character of pulp so that water can be removed with more mechanical power and less heat; heat utilization, and greater development in byproducts.

## Lime Symposium at Spring Meeting of A.C.S.

A symposium on lime has been included in the program of the American Chemical Society for its Spring Meeting at Richmond, Va., April 11 to 16. Three half-day sessions will be devoted to the technical problems involved in the production and use of this material. The fact that 115 industries use lime in one form or another promises an active interest in the subjects discussed.

The following are included in the list of speakers: P. A. Paulson, Kimberly Clarke Paper Co.; Chas. Warner, Chas. Warner Co.; J. V. N. Dorr, The Dorr Co.; A. H. Hooker, Hooker Electrochemical Co.; Prof. G. I. McLaughlin, University of Cincinnati; C. P. Hoover, Columbus, Ohio, Water Purification Works; L. F. Warrick, Wisconsin State Board of Health; W. E. Carson, Riverton Lime Co.; Prof. G. L. Clark, Massachusetts Institute of Technology; V. J. Azbe, Consulting Combustion Engineer; Prof. O. R. Overman, University of Illinois; R. K. Meade, Consulting Engineer. J. R. Withrow, Head of the Department of Chemical Engineering, Ohio State University, is in charge of preparation for the symposium.



## Teeple Awarded Perkin Medal for Developing American Potash

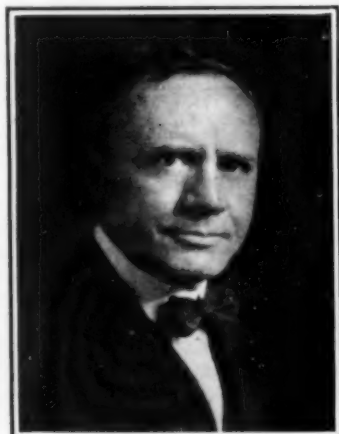
Honored for Distinguished Services in Building a Domestic Industry  
in the Face of Long Odds

CHEMICAL engineering achievements in developing a substantial American potash industry at Searles Lake, Calif., were officially recognized by the major chemical societies of New York City when Dr. John E. Teeple, consulting chemist and chemical engineer, was awarded the Perkin medal. Presentation was made at the meeting of the American section of the Society of Chemical Industry held at the Chemists' Club in New York, January 14. Dr. L. V. Redman, chairman of the meeting, declared that Dr. Teeple's accomplishment was the joint result of "his capacity for highly specialized scientific research and his ability as a business man to hold the confidence of capital until he had turned red figures into black."

Prior to the actual award of the medal by Dr. William H. Nichols, who succeeded the late Dr. Charles F. Chandler to the honored position of senior of the former presidents of the American section, Professor L. M. Dennis, director of the department of chemistry at Cornell University, recalled his earlier association with the medalist, particularly during the five years spent in completing his graduate work at Ithaca. Then Dr. Ellwood Hendrick read a paper by Dr. Charles H. Herty which reviewed Dr. Teeple's versatile accomplishments as a consultant in many apparently unrelated fields.

Referring to the achievement that won for him the present honor—the potash and borax development at Searles Lake—Dr. Herty stated that "millions of dollars had been invested in a multitude of changed plant methods, all of which succeed in making only an entirely inadequate quantity of a product which was of altogether insufficient purity. Whatever was to be done had to be carried out in a desert, the last place in the world one would select for a great chemical plant, and at that far removed from the centers of consumption. More than that, with the cessation of the war and the renewal of imports from Germany, and the hostility of the consumers of fertilizers to any tariff on potash, he was faced with the necessity of putting a product on the market in competition with one of the most powerful and best organized of the so-called world monopolies."

Dr. Teeple's successful handling of this problem was largely the direct outcome of physico-chemical studies of the constituent salts in the brines and particularly in avoiding the formation of the troublesome compound, glasserite,  $\text{Na}_2\text{SO}_4 \cdot 3 \text{K}_2\text{SO}_4$ . The discovery by Mr. Burke of the research staff of a new double salt,  $\text{Na}_2\text{CO}_3 \cdot 2 \text{Na}_2\text{SO}_4$ , which is now called burkeite, and the information obtained from equilibrium studies enabled Dr. Teeple to separate out the sodium sulphate as burkeite instead of glasserite, thus removing the first obstacle. The second problem was to effect complete separation of the potas-



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Dr. JOHN E. TEEPLE

### Perkin Medalist for 1927

IN ADDITION to the work on potash and borax which won for Dr. Teeple the present distinction, he has had a long and varied experience as a consulting chemist and chemical engineer. His clients have included many of the principal chemical manufacturers of the United States. Dr. Teeple was born at Kempton, Ill., January 4, 1874, and received his first collegiate training at Valparaiso College, from which he received a bachelor's degree in science in 1893 and the corresponding degree in arts in 1894. After teaching for four years at Fremont College in Nebraska, he entered Cornell University to complete his graduate work. This gained for him a B.S. degree in 1899 and a Ph.D. in 1903.

EXCEPTING for teaching experience at Cornell from 1899 to 1904 and later (1917) as a special lecturer at Columbia University, Dr. Teeple's career has been given over entirely to consulting work. He is national treasurer of the American Chemical Society, a member of the Society of Chemical Industry, American Electrochemical Society, Société de Chimie Industrielle, American Association for the Advancement of Science, Franklin Institute and the American Anthropological Society. Dr. Teeple is a member of the Chemists Club and served as its president in 1921, 1922 and 1923.

sium chloride from the borax. This was solved by the discovery that pure KCl would separate without any contamination of borax if the hot solution were cooled rapidly and quietly to about 30 deg. The mother liquor on further cooling deposited borax containing a small trace of KCl but this could be readily washed out. With this accomplished the borax became a most valuable asset so that the plant is now operating for the marketing of both products, each of a high degree of purity. Today the Trona plant of the American Potash and Chemical Corporation is the largest

borax plant in the world and ranks with the three or four largest potash plants of Europe.

In accepting the Perkin medal at the hands of Dr. Nichols, the medalist asked that he be regarded as a delegate representing a large and deserving group of co-workers in the Trona organization. And in reviewing the course of the Californian development he took occasion to give generous credit to the research associates, operating staff and the Corporation executives who helped to transform the 1919 plant with its output of 20 tons per day of low grade potassium chloride to its present industrial status—"capable of producing nearly 400 tons per day of very high grade potassium chloride, borax and boric acid and of marketing them at a profit at prices below pre-war levels and in competition with two of those foreign monopolies that are the *bête noir* of Mr. Hoover."

Although the application of sound chemical engineering principles played an important part in the potash development, Dr. Teeple emphasized the necessity for efficient management as it applies to handling labor, freight traffic and especially in connection with sales and distribution. He concluded his address with some practical philosophy on his idea of an ideal industrial organization. "I have dreamed," he said, "of an organization where intelligence ranked higher than office and where ability to contribute was respected above either; where men had a consciousness of the dignity of their work and an appreciation of the same dignity in the work of their fellows, and where loyalty and determination to finish work undertaken were stronger incentives than the lure of the payroll, and where the payroll attempted to keep intelligent pace with the work. This dream, thanks to the co-operation of many, has been more nearly realized during the last seven years than I ever happened to see it elsewhere, and that realization is one of the most important reasons why you are honoring me with the Perkin medal."

### American Institute of Chemists To Hold Conclave

Plans are being developed for a one-day conclave of the American Institute of Chemists to be held at Yale University, New Haven, Conn., Monday, March 28. In accordance with its object "to advance the welfare of chemists" the meeting will be devoted entirely to a discussion of the subject of contracts. The topic will be considered from the point-of-view of both employer and employee, and the legal phases will be presented by an attorney specializing in that subject. The session will be held in the afternoon only and will be followed by a dinner and general meeting, the proceedings of the latter to be broadcast. Details of the speakers and program will be announced later.

## News from Washington

By Paul Wooton

WASHINGTON CORRESPONDENT OF *Chem. & Met.*

EVIDENCE that the United States no longer is willing to remain in tenth place among the nitrogen producing countries of the world has been forthcoming from various quarters during the past month. The maneuvering of the Muscle Shoals bidders has kept nitrogen and fertilizer to the fore on Capitol Hill. There has been discussion of a suggestion that a nitrogen conference be held similar to the very notable exchange of ideas at Pittsburgh recently on the utilization of bituminous coal. Several producers of nitrogen are understood to be considering manufacture for the fertilizer demand and a plan for the establishment of a nitrogen institute is in prospect.

The Muscle Shoals development came from an unexpected quarter. The expectation has been since the first week of the present session that Senator Deneen would press for the consideration of the bill which was reported favorably by the joint committee of the Senate and House, of which he is chairman. He has shown no disposition to call up his bill and even Senator McNary who insisted earlier in the session that the Joint Committee's bill be taken from the calendar and referred to the Committee on Agriculture, has had nothing further to say about the matter at the time of this writing.

No effort was made in the House to consider the bill on the calendar and notwithstanding that fact the Committee on Military Affairs entered upon the consideration of a new bid from a company to be known as the Farmers Federated Fertilizer Corporation, and a revised bid from the American Cyanamid Company.

After several days of public hearings it was announced that neither bid was satisfactory. A sub-committee was appointed to enter into negotiations with the bidders in an effort to amend the bids so they would meet the objections of the committee. These negotiations have been behind closed doors and little is known as to the progress which has been made. Since the session is nearing its end, indications are that the Muscle Shoals controversy will not be disposed of at this Congress.

The revised Cyanamid offer was presented to the House in the form of a bill by Representative Madden of Illinois. Mr. Madden appeared before the Military Affairs Committee and urged it to report favorably on the offer, which he declared to be better than that submitted by Henry Ford, which the committee had approved, for the following reasons:

It leaves the plants to be owned by the government at the end of the lease period, including the improvements constructed by the company; it increases the fertilizer production from 40,000 tons of nitrogen to 50,000 tons; it waives all patent royalties, an element of cost which amounts to \$1,200,-

000 per year saving; the lease is for fifty years and no preference in renewal is provided for; the government retains for use or sale supplies worth \$2,500,000 which would have become Mr. Ford's property under his offer; interest at four per cent is provided on all deferred amortization payments so that the amortization is complete under this offer.

With the end of this session the Muscle Shoals bill now on the calendar, which provides for the lease of the Muscle Shoals property of the government to an association of southern power companies, and to a subsidiary which would undertake fertilizer manufacture, will die. This will leave the situation just as it was in the beginning. The fight which will be conducted before the next Congress will be to determine whether the power not needed for fertilizer manufacture will be distributed for public utility use, or whether it will be used principally in the manufacture of chemicals.

### Chilean Nitrate Developments

Washington also was the center of activities for the Chilean Nitrate of Soda Education Bureau. That organization brought a troop of its prize-winning cotton growers to Washington. The exploits of the young men were made much of in the House. The entire membership rose and applauded when the group entered the visitors gallery. There was sight-seeing and banquets. The Chilean Ambassador presented prizes. Much publicity resulted from all these activities and the Bureau of "Education" is much gratified with the results of its efforts.

Other Chilean developments were followed with much interest by the government's specialists. Commercial Attache Brooks, of Santiago, reported that the guarantee offered by the Nitrate Producers' Association to repurchase unsold stocks of nitrate had stimulated the demand greatly. The fact that the second German firm had notified the association of its intention to sell nitrate in the open market after June 30 was a further indication that full competition among the producers soon will begin. Interest is added to the situation by the fact that the new Guggenheim plant soon is to be in operation.

The knowledge that Muscle Shoals nitrogen is not to come on the market in the near future is expected to stimulate the plans of several domestic producers to undertake the production of nitrogen for fertilizer use. For several years Muscle Shoals has been hanging over the industry, but the launching of ambitious plans at Hopewell, Va., and the probability that relatively small plants are to be constructed at several points that are well located in respect to raw materials, has added greatly to the interest being shown nitrogen.

There is some speculation as to what Japan expects to do with the large nitrogen capacity being installed in that country. Apparently the projects under contemplation will supply more nitrogen than Japan itself could absorb or hope to export in world trade at this time. The thought has occurred to some that Japan may be contemplating a campaign which will result in a larger use of fertilizers in China and thus extend Japan's markets.

The conference of the key men in the chemical industry held in Washington in December so impressed some of those who attended that they are suggesting the formation of a chemical council to promote the interest of the industry in a broad way. The individual associations are busy with their own problems and have a limited field of operation. If an organization could be set up in which the associations would be represented it would give an opportunity to work for the stimulation of export trade and other objectives which are essential to the welfare of the industry as a whole. Thought on the subject has not crystallized and no effort as yet has been made to sound out the industry, as a whole.

### French Dye Cartel

Information from France indicates that negotiations are in progress looking to the establishment of a dye cartel. If successful it will mean close co-operation between the Kuhlmann and St. Denis interests and the Swiss Company producing at St. Fons. Such a combination would have an important bearing on the German situation after the expiration, late in 1928, of the reparations agreement. Anticipating keener competition in France, the German I. G. is said to have perfected plans for the establishment of production in France.

Acquisition of a considerable block of Wintershall stock by the Burbach Potash Concern paves the way for a potash supertrust in Germany along the lines of the dye cartel. This is expected to result in a policy of higher prices. The Wintershall group, which always has stood for small profits and larger sales, is greatly weakened and now has little opportunity to impress that policy on the German industry. It is expected that the potash syndicate will set up a joint sales agency in the United States along the line of the one recently opened in England.

Negotiations are in progress between the I. G. and an American petroleum refiner, it is understood, looking to the construction of an American plant for the distillation of coal under the patents of the German cartel. There is increasing evidence that the Germans believe that the time is near when motor fuel from coal will be able to compete with gasoline. It has been recognized for some time that competition is possible at the prices of gasoline prevailing in European countries, but the news that a serious venture to compete with twenty-one cent gasoline in this country is under contemplation, comes as a surprise. There also is evidence that the new Imperial Chemical Trust in Great Britain is making definite plans for the commercial application of coal distillation.



## Recent British Chemical Merger May Develop Coal Processing

### Directors of Amalgamated Company Actively Connected With the Exploitation of the Bergius Process

(From our London Correspondent)

THE beginning of the year has brought the usual crop of reviews of the past year and of its depressing features, tempered by tales of technical and industrial achievements and of the psychological effect of the creditable manner in which the community behaved during the great strike.

The amalgamation of four leading firms under the name of Imperial Chemical Industries has been widely discussed. The new chemical merger has been accomplished with efficiency and despatch and is rapidly getting into its stride. The constituent firms always have been more or less free from labor troubles and the intention is to conserve this asset by an extension of co-operative welfare work. In some respects, the chemical merger is proceeding along lines already followed abroad and this is best exemplified by the fact that certain directors of Imperial Chemical Industries have joined the board of International Combustion, Limited, thus more definitely linking up the future of the chemical industry with coal. Sir Alfred Mond has been actively associated with fuel development for some years and other members of the merger have been actively connected with the international development of the Bergius process, but it will be a matter of great interest to observe whether ultimately the participation of the chemical industry in fuel problems will be envisaged on a scale corresponding to that already being practiced in Germany and elsewhere.

Low temperature carbonization, oil and briquetting problems continue to attract attention and a most comprehensive review was published in the *Journal of the Society of Chemical Industry* of January 14. At the same time, the report of the Fuel Research Board for 1925 appeared and from this it is clear that all these matters are likely to receive intensified attention with government support. The Nielsen-Laing or the "L. & N." type of retort is to be developed by a new company with a capital of over a million dollars and the Salermo process is also making headway.

An interesting illustration of the way in which chemical engineering penetrates into the most unlikely places is that of the Marine Cellulose Syndicate, formed to utilize sea grass of the *zostera marina* type sometimes known as "varech de Mer." A beginning is to be made with the grass which is frequently thrown up along the shores of the Etang de Berre, near Marseilles, and the conversion of this material into a non-inflammable bleached and germ-proof packing material has presented very interesting chemical and engineering problems. The sea grass is in strands about 3 feet long and half an inch wide and after suitable washing and treatment, is readily bleached and

dyed. It is very elastic and this and its other properties may render it extremely valuable for packing goods for the United States, for which purpose hay and straw are prohibited. Wood wool has the disadvantage of being inflammable and it is anticipated that a very profitable market is immediately available merely for the packing of fruit. Leading authorities on cellulose have investigated the material and have also expressed the opinion that it should be suitable for use in other directions requiring cellulose as a raw material, so that the enormous surplus that seems available at present may ultimately also find an outlet other than that provisionally suggested as a manure. As sea grasses of this type occur in the United States and many other parts of the world, the development of this enterprise should be peculiarly interesting and it might be added that a well known American chemical engineer has been identified with much of the pioneer work underlying the practical working out of the methods used.

### Allied Chemical Chooses Hopewell for Nitrogen Plant

Officials of the Allied Chemical & Dye Corporation announce the purchase of a large site at Hopewell, Va., where it is likely that a plant for the fixation of atmospheric nitrogen will be erected in the near future. The Corporation's investment in fixed nitrogen process development is said to be about \$4,500,000, and as this investment has yielded encouraging results, the full-scale operations at Hopewell will probably be the biggest yet attempted in this country, although details of the project are not forthcoming at this time.

This announcement, coming shortly on the failure of the Corporation to declare an extra dividend in the form of stock, appears to indicate disposal of part of the large surplus funds in new construction at Hopewell.

### Court of Appeals Upholds Rubber Accelerator Patent

On appeal from the District Court of the United States for the Western District of Pennsylvania, the Dovan Chemical Corporation, assignee of Morris L. Weiss obtained a reversal of decision in its suit against the Corona Cord Tire Company. In the original action the Dovan Chemical Corporation charged the Corona Cord Tire Company with infringement of Weiss patent No. 1,411,231 which covers the acceleration of rubber by a di-substituted guanidine, such as diphenylguanidine. As reported on p. 105 of the February, 1926 issue of *Chem. & Met.*, Gibson, District Judge, declared the Weiss patent invalid on the grounds that

Weiss was not the inventor or discoverer of the efficacy of diphenylguanidine as a vulcanization accelerator. The Court of Appeals, however, has reversed this decision, declaring in part: "Without entering into details and a discussion of the proofs we may say they satisfy us that Weiss was the first to instruct the rubber art in this mode of rubber vulcanization and that up to his work the rubber art had made no use of D.P. G. in vulcanization and no one had therefore disclosed to the art or instructed it how D.P.G. could be practically produced, or of course, practically used."

### Compressed Gas Manufacturers Hold Technical Sessions

In its meeting on January 24 in New York the Compressed Gas Manufacturers Association had two sessions for the presentation of technical papers. This is the first time in the history of this organization when the annual meeting has extended beyond the consideration of Association business to include technical matters.

The report of the secretary indicates that the association is continuing its service to member companies largely in the fields of freight-rate and classification matters, protection against unduly restrictive or unsound legislation affecting the business, and co-operation with the Interstate Commerce Commission and the Bureau of Explosives of the American Railway Association on safe packaging and transportation of compressed and liquefied gases.

Especially important activity was shown in the report of the transportation committee which has dealt with classification of empty cylinders returned by freight; the minimum weight for which charge is made on sulphur dioxide shipments by tank car; the proposed increase in minimum carload charges on anhydrous ammonia in tank cars; and other proposals affecting tank car movement of liquefied gases.

A paper discussing "Changes in Gas Cylinder Steels During Service," by K. G. Jobson, of the Union Carbide and Carbon Research Laboratories, was presented by J. J. Murphy, due to the illness of the author. A paper presented by Dr. I. C. Gardner, of the U. S. Bureau of Standards, aroused much interest in the subject, "Optical Methods of Inspecting Pressure Vessels." At the afternoon session three technical papers were presented. The article on "Compressed Gas Technique," by F. A. Ernst, of the Fixed Nitrogen Research Laboratory, will be reported later in *Chem. and Met.* Dr. J. M. Arthur, of the Boyce Thompson Institute for Plant Research described "Some Effects of Carbon Dioxide and Light on Plant Growth and Flowering." The third technical paper of the afternoon session was "Progress in the Compressed Gas Industry — Converting Dreams to Dividends," by R. S. McBride, Assistant Editor of *Chem. and Met.*

The officers of the Association elected for the coming year are: J. C. Minor, president; H. S. Smith, first vice-president; P. Samuel Rigney, second vice-president; and John H. Luening, secretary and treasurer.

## Plans for Enlarged Production of Methanol in France

One New Plant Is About Ready to Operate and Others Are Under Discussion

From Our Paris Correspondent

**M**ETHANOL production in France will be given a decided impetus when the new plant of the Mines de Lens, a big colliery in the North of France gets into operation. The plant is now under construction and will be completed this month or in March. The plant will have an initial daily output of one to one and one-half tons of methanol. If results are satisfactory the output will be enlarged. The Audi-herbert process will be employed. The Kuhlmann concern also is planning to erect a plant for the production of synthetic methanol and will make use of the Patart process. It is not stated definitely what the capacity of the latter plant will be but it is said that it will turn out several tons daily.

In connection with the production of synthetic methanol it is worthy of note that a company has been formed, called the Société Française de Catalyse Généralisée which will take over the patent and processes of Prof. Charles Henry who died last November. Prof. Henry is credited with having worked out a mathematical law which makes it possible to determine the best catalyst for use in any given action. Prof. Henry took out a patent on his process, French patent No. 215,822. This patent now is controlled by the newly formed company. By the use of this patent it is claimed that an output of synthetic methanol can be obtained at a rate 40 per cent higher than is given by any other process. The company does not plan, at least immediately to begin production of synthetic methanol but will equip a laboratory to complete the study of catalyzers as started by Prof. Henry.

In contrast to the progress made in industrial production of methanol is the lack of success in turning out synthetic ethyl alcohol. The Mines de Béthune using the ethylene process is reported to have suspended operations because the duties placed on alcohol by the French State were too high to enable them to operate at a profit.

Representatives of the potash industry in France and Germany finally came to a definite arrangement concerning the sales distribution of this product. The new arrangement stipulates that all orders are to be divided between the two countries on a basis of 70 per cent to the German syndicate and 30 per cent to the Société Commerciale des Mines de Potasse. As world's consumption of potash increases the share of the French producers will be increased and when total sales exceed 840,000 tons of pure potash the proportion will be equal between French and German producers. In any event the sales quotas will be on an even basis after five years have elapsed.

The French State is finding it an expensive proposition to establish production of synthetic ammonia at its plant at Toulouse. The plant has not yet produced any ammonia yet the cost

to date has been about 162 million francs. As the plant is expected to operate on a scale large enough to turn out 50,000 tons of ammonia sulphate yearly, it was found necessary to increase the appropriation of 180 million francs as originally made by the state and a further credit of 75 million francs has been voted which removes the possibility of financing the undertaking by public subscriptions.

### Ductile Tungsten Declared to Be No Invention

In an opinion handed down by Judge Hugh M. Morris in the District Court of the United States for the District of Delaware, U. S. Patent No. 1,082,933 granted to General Electric Company as assignee of William D. Coolidge and relating to improvements in tungsten and methods of fabricating ductile wire of that element was declared to be invalid for lack of invention. The General Electric Company, plaintiff, charged the DeForest Radio Company and Robelin Piano Company, defendants, as infringers through the manufacture and sale of radio tubes having ductile tungsten filaments. The broad defenses were invalidity and non-infringement.

The decision is significant in that a sharp distinction is drawn between discovery and invention. The opinion states in part: "Were workableness at some temperature of pure tungsten in a coherent mass not a natural and inherent property of that element or mass, obviously it could not be worked at all. Hence, the initial workableness, as I see it, cannot be otherwise than a discovered property of the metal in such a mass and is not an invented or artificial characteristic. . . . So far as the validity of the product claims is concerned it is, of course, immaterial whether tungsten ductile cold was the result of one discovery or of a series of discoveries. The decisive factor is that it is a discovered, inherent property, not an invented one." The opinion further states: ". . . the failure to draw tungsten before the present century is a fact of little significance. I now think, in determining the presence or absence of invention in the claimed process of drawing tungsten. That process must stand or fall on its merits. Of what does it consist? Nothing more as I understand the record in the present case, than the application of the old metal working processes to a coherent or solid mass of tungsten. Coolidge was not the first to conceive of or even create such a mass. . . . There were difficulties of moment to be overcome before the old processes could be successfully applied but their solution lay in the field of discovery and not, as I view it, in that of invention.

It is shown, ". . . that Dr. Colin G. Fink, not Dr. Coolidge, was the one who did the work in the laboratories

of the plaintiff upon molybdenum; that Dr. Fink did the work in the summer of 1908 while Dr. Coolidge was abroad; that in doing it he followed his own ideas; that a patent application for his work was prosecuted to allowance by the plaintiff and then abandoned; that molybdenum a sister or analogous metal to tungsten under the Mendeleeff classification of elements, is normally brittle in the same sense that tungsten is, and is affected by heat and mechanical forces in the same way. Dr. Coolidge returned to the laboratories in September, 1908. The process by which molybdenum had been drawn was made known to him. Tungsten was drawn for the first time in the laboratories of the plaintiff a few weeks later by the same process and with substantially the same results. I think both answers of the defendants to the contention of the plaintiff are sound and that the process claims under consideration are invalid for want of invention."

### General Ceramics Co. Under Former Ownership

The General Ceramics Co., with chemical stoneware plant at Keasbey, N. J., and sanitary ware pottery at Metuchen, N. J., has returned to its German ownership prevailing before the war, a controlling interest having recently been acquired by the N. Jungeblut Deutsche Ton-und Steinzeugwerke, which will maintain operations at both plants, as heretofore. Lewis Albrecht has been elected president and general manager.

### Cost Accounting for Sulphuric Acid and Acid Phosphate

The National Fertilizer Association has just published and distributed to its membership a new cost accounting and cost estimating system for manufacturers of sulphuric acid and acid phosphate which has resulted from an extended study by its cost accounting committee. The association is prepared to assist member companies in installing this system as well as the simpler system for dry-mixing plants. This system of cost accounting is one which is receiving special attention by the Association because it believes that the application of the recently adopted "Code of Trade Practices" will not be feasible throughout the industry unless a real knowledge of costs of production is available to each manufacturer.

### Industrial Alcohol Makers Establish Fellowship

The Industrial Alcohol Manufacturers' Association has founded an industrial fellowship in Mellon Institute of Industrial Research of the University of Pittsburgh, for the purpose of studying denaturants, in order to find an ideal one, if possible. This would be a substance possessing such properties and physiological action that it would render ethyl alcohol undrinkable, but could not be separated in any way from the alcohol and would not injure it for technical uses. The creation of this fellowship and its acceptance by Mellon Institute are especially noteworthy in objective.



## Men You Should Know About

J. ALEXANDER WILSON, chemical engineer and for some time general sales manager of the Beckwith-Chandler Co. of Newark, N. J., has been made vice-president of that company.

SAMUEL J. McDOWELL, superintendent of the Bureau of Standards station at Columbus, Ohio, has resigned to accept a position with the Corning Terra Cotta Co., Corning, N. Y.

WALTON CLARK of Philadelphia, was honored recently as the first recipient of the Walton Clark medal of the Franklin Institute for "original and notable work in the gas industry." The medal is endowed by the United Gas Improvement Co., of which Mr. Clark formerly was vice-president. He is also a former president of the Institute.

Dr. M. L. HARTMANN, formerly director of research for the Carborundum Co., Niagara Falls, N. Y., has become technical director for the Celite Products Co., with headquarters at Lompoc, Cal. Dr. Hartmann was at one time head of the department of chemistry, South Dakota State School of Mines.

F. J. ENRIGHT has been appointed chief instructor at the Goodyear Industrial University, Akron, O., devoted to the teaching of rubber manufacturing practice, affiliated with the Goodyear Tire & Rubber Co. Mr. Enright is a graduate of the University of Iowa.

Dr. ROBERT NORTON PEASE has accepted an appointment in the department of chemistry, Princeton University, as research associate. He is on a leave of absence from the University of Virginia, where he is associate professor of chemistry. Dr. Pease is a research fellow of the American Petroleum Institute.

GEORGE HERBERT JONES of Chicago, Ill., president of the Hillside Fluor Spar Mines and a director of the Inland Steel Co., has tendered a gift of \$415,000 to the University of Chicago, for the equipment and endowment of chemical research. Part of the fund will be devoted to a building to be known as the George Herbert Jones Research Laboratory.

A. L. CARLSMITH has accepted an appointment as chemist for the Commercial Solvents Corp., at its Terre Haute, Ind., plant.

S. W. ALLENDER has been appointed assistant superintendent at the acid and intermediate plant of the Monsanto Chemical Works, Monsanto, Ill.

Dr. FELIX SINGER, German ceramic engineer, is on a visit to the United States, making a tour of inspection of a number of plants in the industry.

BERNARD BARUCH has become technical director and superintendent for the Central Paint & Varnish Works, Brooklyn, N. Y.

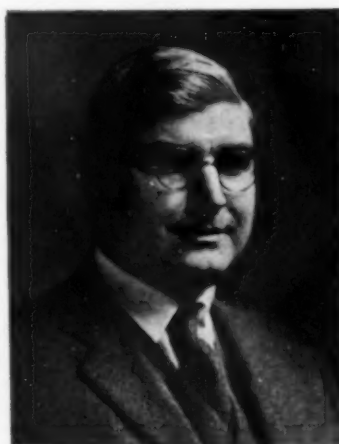
M. J. CONNOLLY recently has been elected president of the Cellulose Products Co., Marcus Hook, Pa.

J. E. EGLESON, assistant to the vice-president in charge of engineering research and mines, General Chemical

Co., New York, with which company he was affiliated for 21 years, has accepted an appointment with Congoleum-Nairn, Inc., Philadelphia.

DAVID F. SIRDEVAN, assistant works manager for the General Chemical Co., New York, and identified with that company for the past 30 years, has resigned.

F. C. HETTINGER, who has been employed since 1916 as a chemical engineer in the production department of the U. S. Industrial Chemical Co., has been made superintendent of the plant at Curtis Bay, Md. Associated with



(C) Bachrach  
Frederick C. Hettinger

other engineers under the direction of Dr. M. C. Whitaker and Dr. A. A. Backhaus, Mr. Hettinger has been closely connected with all of the original development work on the evaporators, rotary furnaces and incinerators as well as the Cottrell precipitators, ammonia absorption towers and waste heat boilers which were later added to the plant operating equipment.

EDWARD CALDWELL has resigned from the presidency of the McGraw-Hill Book Co., New York, and will retire from active business. Mr. Caldwell has been associated with the McGraw-Hill interests for thirty-six years. He will remain on the Board of Directors of the McGraw-Hill Book Co., Inc., and the McGraw-Hill Publishing Co., Inc. Martin M. Foss has been chosen to succeed Mr. Caldwell as president of the Book Company.

Professor WILLIAM L. DEBAUFRE has resigned from the Department of Mechanical Engineering of the University of Nebraska to take up work as an executive of the research division of the International Combustion Engineering Corp., New York. F. W. Davis, formerly representing the Bureau of Mines at Lincoln, Nebraska, is joining Dr. DeBaufre's organization.

R. S. MCBRIDE and CHAPLIN TYLER, assistant editors of *Chem. & Met.*, addressed the New York Section, American Electrochemical Society, at its Feb. 4 meeting. The topic was power supply for the chemical industry, with particular reference to recent developments on the Saguenay River.

R. C. BENNER has been appointed director of research of the Carborundum Company, with headquarters at Niagara Falls, N. Y. Dr. Benner has already left his position as a member of the research staff of the General Chemical Co. to take up this new work.

WALTER M. BERRY, who has been executive engineer of the California Gas Research Council, is now practicing consulting gas engineering with headquarters at 810 Flower St., Los Angeles, Calif.

R. B. BROWN, president of the Milwaukee Gas Light Co., has been elected president of the American Light and Traction Co., New York, succeeding A. B. Lathrop, who becomes chairman of the Board of the corporation.

J. A. ALMQUIST has resigned from the staff of the Fixed Nitrogen Research Laboratory to accept a position with Lazote, Inc., with headquarters at Charleston, W. Va.

ALFRED E. SOISSONS, a chemical engineer formerly associated with the National Aniline & Chemical Co. of Buffalo, and later engaged in consulting engineering work, has taken an interest in the Queen City Warehouse Corp. of Buffalo, N. Y., which specializes in warehousing service to the chemical trade, covering chemicals and chemical equipment. Mr. Soissons is acting as general manager.

ARTHUR A. ZENTNER, research and metallurgical engineer, has established an office at 74 New Montgomery St., San Francisco.

LESTER O. RICHTER, who has been for some time in charge of positive production for the Technicolor Company, is now with the California Petroleum Co. as a research engineer in a newly organized department of experiment and development at the Wilmington, Calif., laboratories. His address is 821 East State Street, Long Beach, Calif.

CHARLES BREITUNG, who has been located at Shreveport, La., engaged in work related to natural gas resources, is now in Los Angeles, Calif., in similar work. His address is 824 Alden Drive, Beverly Hills, Calif.

J. G. COUTANT, who has been for the last three years consulting and combustion engineer for the Furnace Engineering Co., has opened an office as consulting fuel engineer at 26 Cortlandt St., New York, N. Y.

JAMES M. KEATING, who has been with the General Chemical Co. over 15 years, has resigned to accept a position with Congoleum-Nairn, Inc., Philadelphia.

Dr. PARRY BORGSTROM is now connected with the chemical laboratory of Johns Hopkins University, where he will have charge of research on the detection and identification of sulphur compounds in petroleum. Dr. Borgstrom formerly was on the chemistry faculty of Tulane University.

JOSEPH J. HICKEY and CHARLES J. THATCHER have incorporated as Tapcor, Inc., for the purchase, sale or licensing, on a commission basis, of patent and similar rights, or for the marketing of patented devices. Offices are at 475 Fifth Ave., New York, N. Y.

E. J. DURHAM, formerly plant chemist with the Crown Willamette Paper Co., has accepted a fellowship

in chemistry at the Rice Institute, Houston, Texas.

Prof. ROGER ADAMS, head of the department of chemistry of the University of Illinois, is to receive the 1927 impression of the William H. Nichols medal, the award being made by the New York Section of the American Chemical Society at its meeting March 11. The medal is a recognition of Dr. Adams' work on "Acids of Chaulmoogra Oil and Related Compounds," which he will discuss on the occasion of the presentation of the medal.

WILLIAM RUSSELL, managing director of the Door Co., Ltd., London, England, is in this country familiarizing himself with engineering achievement in the United States since his last visit eighteen months ago. His headquarters are at the Dorr Co., New York.

HARRY F. GLAIR, who has been assistant superintendent in the Standard Oil Co. of Indiana, has been made general superintendent of the Whiting, Indiana, refinery.

ARTHUR B. HAMBY has become associated with Edw. W. Lawler, Inc., Metuchen, N. J.

BORDER BOWMAN, formerly of Staley & Bowman of Columbus and Springfield, Ohio, and ALBERT F. NATHAN, announce the partnership of Nathan & Bowman, with offices in the Singer Tower at 149 Broadway, New York, where they will continue their practice as patent counsel and solicitors.

Dr. LEONARD H. CRETCHER has been appointed head of the department of research in pure chemistry, at Mellon Institute of Industrial Research, Pittsburgh. Dr. Cretcher has been a senior fellow of the Institute in charge of fundamental chemical studies since 1922. He will have supervision over all the Institute's investigations in pure chemistry and will also serve as an advisor to industrial fellows who are carrying on research on problems in synthetic organic chemistry. Dr. WILLIAM L. NELSON has been named as the first fellow in the department.

Dr. PAUL M. GIESY, until recently director of the Brooklyn Research Laboratories of E. R. Squibb and Sons, is now engaged in consulting practice, handling chemical and pharmaceutical work, and can be addressed at 165 Broadway, New York.

J. N. CAROTHERS, technologist, Federal Phosphorus Co., Anniston, Ala., since 1919, has been elected vice-president of the company.

JOSEPH R. LORENZ has joined the staff of Skinner, Sherman and Eselen, Inc., Boston, for the purpose of organizing a department of leather chemistry to render research, analytical and advisory service for tanners.

HARRY V. WELCH, chief metallurgist of the Western Precipitation Co., Los Angeles, Calif., is making a trip through the eastern part of the United States and Canada and conducting tests in various plants where the Cottrell processes of electrical precipitation are being considered in connection with dust and fume problems.

FREDERICK M. FEIKER, formerly vice-president and editorial director of the McGraw-Hill Co. and later operating vice-president of the Society for Elec-

### Calendar

AMERICAN CHEMICAL SOCIETY, Richmond, Va., April 12-16, 1927.

AMERICAN ELECTROCHEMICAL SOCIETY, Philadelphia, April 27, 28 and 29.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, Cleveland, Ohio, May 31, June 1, 2, 3.

AMERICAN INSTITUTE OF CHEMISTS, conclave, Yale University, New Haven, Conn., March 28.

AMERICAN LEATHER CHEMISTS ASSN., annual meeting, Cincinnati, Ohio, June 15, 16 and 17.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, spring meeting, White Sulphur Springs, W. Va., May 23 to 26.

BRITISH INDUSTRIES FAIR, London and Birmingham, Feb. 21 to Mar. 4.

COMMON BRICK MANUFACTURERS' ASSN., Chicago, Feb. 21 to 24.

LEIPZIG TRADE FAIR, Leipzig, Germany, March 6 to 12, 1927.

NATIONAL COLLOID SYMPOSIUM, Ann Arbor, Mich., June 22 to 24.

TECH. ASSN. OF THE PULP & PAPER INDUSTRY, New York, Feb. 21 to 24.

trical Development has become managing director of the Associated Business Papers, Inc., national organization of the technical and business press.

### Industrial Notes

THE MERCO NORDSTROM VALVE Co., San Francisco, Calif., has leased a new building in Oakland for the manufacture of its valves for the Pacific Coast. Machinery for the new plant is now being ordered and the plant is expected to be ready to operate in the late spring or early summer.

THE INTERNATIONAL COMBUSTION ENGINEERING CORP. announces the acquisition of the capital stock of the Heine Boiler Co., water-tube boiler manufacturers. Mr. C. R. D. Meier will remain as president of the Heine Boiler Co.

THE SEMET-SOLVAY ENGINEERING CORP., 40 Rector St., New York City, a division of the Allied Chemical & Dye Corp. has just been formed. It is a consolidation of the Steere Engineering Co. of Detroit and the engineering and construction departments of the Semet-Solvay Co. of New York. The new company will manufacture and erect all types of modern byproduct coke ovens, manufactured gas plants, their equipment and auxiliary apparatus.

GODFREY L. CABOT, INC., Boston, Mass., announces that C. R. Johnson has joined its staff in the capacity of technical director and is organizing a carbon black laboratory.

THE MILLS CO. AGENCY, New York, an export advertising agency, has added to its staff Arthur F. Connolly, who will fill the office of vice-president and account executive.

THE AUTONOMOUS INDUSTRIAL COLONY "KUZBAS" announces the liquidation of the New York office. All current business will be turned over to the Amtorg Trading Corp., 165 Broadway, New York City.

The Gross Lead Burning & Coating Corp. has removed its plant and offices to 3955 West 25th Street, Cleveland, Ohio.

THE AMERICAN CYANAMID Co. announces the removal of its New York offices to the new Central Mercantile Bank Bldg., 535 Fifth Ave. This removal will also include the offices of its associated companies: American Cyanamid Sales Co., Fumigator Supply Co., Owl Fumigating Corp., Amalgamated Phosphate Co. and Air Nitrates Corp.

THE "INDUSTRIAL BULLETIN OF ARTHUR D. LITTLE, INC." is the title of a publication that is to appear monthly beginning with January, 1927. The purpose of the Industrial Bulletin is to place before bankers, investors and industrial executives timely and authoritative information of technical developments and their probable significance. Upon request to Arthur D. Little, Inc., 30 Charles River Road, Cambridge, Mass., the bulletins will be mailed without charge.

THE AMERICAN BRASS Co. announces that arrangements have been completed whereby it will take over the manufacture and sale of Everdur metal from the duPont Ever-

THE INTERNATIONAL COMBUSTION ENGINEERING CORP. announces its removal with its American subsidiaries, Combustion Engineering Corp., Ladd Water Tube Boiler Co., and the Raymond Bros. Impact Pulverizer Co., Inc., to its new building at Madison Ave., 35th to 36th Streets, New York City.

THE BOTTFIELD REFRACTORIES Co., Philadelphia, has appointed the following concerns as distributors for its product, Adamant fire brick cement: Southern Steel and Cement Co., Asheville, N. C.; Henry A. Petter Supply Co., Paducah, Ky.; Columbia Supply Co., 823 West Gervais St., Columbia, S. C., and Spartanburg Mill Supply Co., 218 Ezell St., Spartanburg, S. C.

THE DINGS MAGNETIC SEPARATOR Co. has established an office at 304 Rice Building, Boston, Mass., in charge of George H. Walsh.

THE CLEVELAND WORM & GEAR Co., Cleveland, Ohio, has established a district sales office in Detroit, Mich., in the Buhl Bldg. H. A. Sparrow is in charge as district manager.

THE C. O. JELLIFF MANUFACTURING CORP., Southport, Conn., manufacturers of wire cloth, baskets and containers, has appointed Sholes, Inc., to represent them in the metropolitan district of New York.

THE QUIGLEY FURNACE SPECIALTIES Co., New York, has appointed George A. Russ to the service staff to cover the Central South and South Atlantic states. He will make his headquarters at Atlanta, Ga.

PFALTZ & BAUER, INC., of New York, announces the retirement of Henry Pfaltz, its president for many years. Mr. Pfaltz has disposed of his stock interest to Frank M. Bauer, who will continue in the sole and active management of the business.

The name of THE GRATING COMPANY OF AMERICA, Pittsburgh, Pa., has been changed to The Tri-Lok Company.

ARTHUR D. LITTLE, INC., celebrated its fortieth anniversary at a banquet in its laboratories on Dec. 30, which was attended by one hundred or more present and former members of its staff. Dr. James F. Norris presented the congratulations of the chemical profession and greetings were read from former associates. Dr. Little briefly reviewed the development of his organization from Oct. 1, 1886, as the firm of Griffin and Little, on the top floor of 103 Milk St., Boston, to its present model industrial research laboratory building on Charles River Road, Cambridge, in which the company now does almost annually more business than in the first twenty years of its existence.

THE U. T. HUNGERFORD BRASS & COPPER Co. has merged with the Chase Brass Companies, Inc., thus increasing its mill facilities.

THE CONNERSVILLE BLOWER Co., Connerville, Ind., has opened a sales office in Room 604, Chamber of Commerce Bldg., Pittsburgh, which will be in charge of Bernard C. O'Brien.

M. B. URQUHART has assumed the Western management of the Philadelphia Grease Mfg. Co. of Philadelphia, Pa., with office and warehouses located in the Ideal Bldg., Denver, Colo., and 144 South Fifth West St., Salt Lake City, Utah.

JAMES L. MAYER and FREDERICK E. OSWALD announce the opening of a sales office for industrial engineering equipment at 322 So. LaSalle St., Chicago, Ill. They are now representing the Dings Magnetic Separator Co. and the Saginaw Stamping & Tool Co.

THE SOUTHERN COTTON & PAPER Co., INC., Chattanooga, Tenn., has changed its name to Southern Chemical Cotton Co., Inc.

THE KALBFLEISCH CORP. has appointed Joseph D. Lowrey as assistant sales manager of the heavy chemicals division.

THE BUFFALO FORGE Co., Buffalo, N. Y., and the BUFFALO STEAM PUMP Co. announce that the Philadelphia office in the Land Title Bldg. will be in charge of W. S. Koithan and R. W. Pryor, Jr., who have for many years been joint managers of the New York office, which positions they still hold.

THE PATTERSON FOUNDRY AND MACHINE Co., East Liverpool, Ohio, announces the appointment of Ernest A. Hayes of Chicago, Ill., as Central Sales Manager with headquarters at Chicago.

THE ZAPP LUMBER Co., East Aurora, New York, has opened a department for making all kinds of wood tanks and vats for use in the chemical engineering industries. The sales office is in charge of Frank A. DeLisle at 1015 Mutual Life Building, Buffalo, N. Y.

E. H. SARGENT AND Co., Chicago, manufacturers of laboratory supplies and equipment is celebrating its 70th anniversary this year.



# Market Conditions and Price Trends

## Consumption of Chemicals Show Gain During Past Month

Slower Movement in December and Early January Has Been Succeeded By More Normal Demand

GENERAL broadening in demand for chemical and allied products has been reported since the middle of January. With the passing of inventory periods, manufacturing operations have assumed a more normal condition and consumption of raw materials is on a wider scale than it was for the period from December 15 to January 15. Based on consumption of electrical energy in manufacturing plants, ELECTRICAL WORLD estimates that industrial operations in January were about 4.4 per cent above the December rate which is about the normal increase in general activity as compared with productive operations of preceding years. General activities in January, however, are estimated at about 5 per cent below the rate for January, 1925.

The position of the chemical industry is reported to be in harmony with that as given as for general business but exceptions are found as instances in the case of the cotton goods branch of the textile industry where operations are of a wider latitude than was the case a year ago.

Industrial operations in 1926, among the groups which are large consumers of chemicals may be shown in a relative way by a study of the indexes of employment and of payrolls with some allowance to be made for the greater efficiency which has been developed within those industries. The accompanying table sets forth the average indexes for the year as reported by the Bureau of Labor. The average for 1923 is taken as 100.

Employment and Pay-Roll Indexes

	Average Indexes for 1926	
	Employment	Pay-Rolls
Dyeing and finishing		
textiles	97.9	100.1
Leather	91.2	93.5
Paper and pulp	101.1	109.5
Chemicals	95.3	103.5
Fertilizers	103.9	108.9
Glass	99.0	108.0
Automobile tires	109.8	113.4
Petroleum refining	100.3	97.9

Estimates that demand for fertilizer in the cotton-growing states would be curtailed this year, appear to have been well founded. Sales of tags in December were 6.9 per cent smaller than in December, 1925, and in January sales fell off 19.1 per cent from the total reported for the corresponding period of 1926. Recent recoveries, however, in the price for cotton have given a more cheerful aspect to the fertilizer situation and it is not probable that falling off in consumption for the season will be as large as the decline reported for

January. On the other hand it seems assured that there will be a reduction in the cotton acreage this year and also in the sales of fertilizer. This will have an immediate bearing on demand for fertilizer chemicals with prospects favoring a contraction in the outlet for sulphuric acid, sulphur, pyrites, nitrate of soda, and sulphate of ammonia.

With the majority of basic chemicals established at steady levels the average of prices is influenced largely by fluctuations in the miscellaneous groups. However, the position of such important materials as lead carbonate and lead sulphate has been weakened by the trend of the metal market and with an easier tone to denatured alcohol, the weighted index number for chemicals has declined to 112.79 which compares with 113.76 a month ago and 112.32 a year ago. Sulphate of ammonia also has been working more in buyers favor and other ammonia compounds have failed to improve their position and with conflicting reports regarding future production of aqua and anhydrous ammonia it is difficult to obtain a perspective of their price inclinations.

Market values for oils and fats have shown a decided tendency to harden during the month. The upward movement has been let by cottonseed oil. Low prices for the latter have encouraged increases in consumption especially in the compound trade and if the cotton acreage is materially lowered

this year, a strong market for oil may rule during the late spring months and throughout the Summer. Linseed oil has been more firmly held but another large seed crop has been produced in the Argentine which indicates that oil values should not be subjected to drastic changes in either direction. Difficulties in transporting China wood oil from interior points in China have restricted offerings for prompt and nearby shipment and thus created a strong market the continuance of which will depend on conditions at primary points. The weighted index number for oils and fats now stands at 137.14 as contrasted with 127.35 last month and 152.43 last year.

The Department of Commerce reports that exports of chemicals and allied products from the United States increased 8 per cent in 1926—from \$167,500,000 in 1925 to \$181,000,000 in 1926. December's foreign sales, amounting to \$17,467,000, were the highest for the past two years, chiefly on account of the high values of the naval stores and crude coal-tar distillates.

There were no particularly significant changes during the years 1925 and 1926, although prices played rather an important part in the trade in a few commodities. Notwithstanding the higher quotations for some of the commodities, especially rosin, crude drugs, and sulphur—which were offset to a certain extent by lower prices for peppermint oil, linseed oil, and coal-tar dyes—there was still a gain in the total trade.

As an indirect result of the British coal strike, exports of crude benzol were largely responsible for the 31 per cent rise in coal-tar values. Industrial chemicals showed an 8 per cent improvement.

Although the majority of the individual commodities of the industrial chemical group reflected a slightly downward tendency during the year, the total group enlarged 8 per cent to \$31,478,000. This increase was made in all probability in the disinfectant and insecticide class and in the foreign sales of specialties. In 1925 there were included in "all other industrial chemicals except medicinal and pharmaceutical preparations." In 1926 the group, "disinfectants, insecticides, fungicides, and similar preparations and materials," was removed from this classification and exports recorded separately attained a value of \$2,722,000.

When it is considered that in 1925 this class was included with the group and in 1926 omitted, and yet the "all other" class advanced over \$300,000 from \$9,074,000 to \$9,379,400, one can perceive the strides that are being made in the development of foreign markets for the so-called specialties, one of the newer branches of the chemical industry.

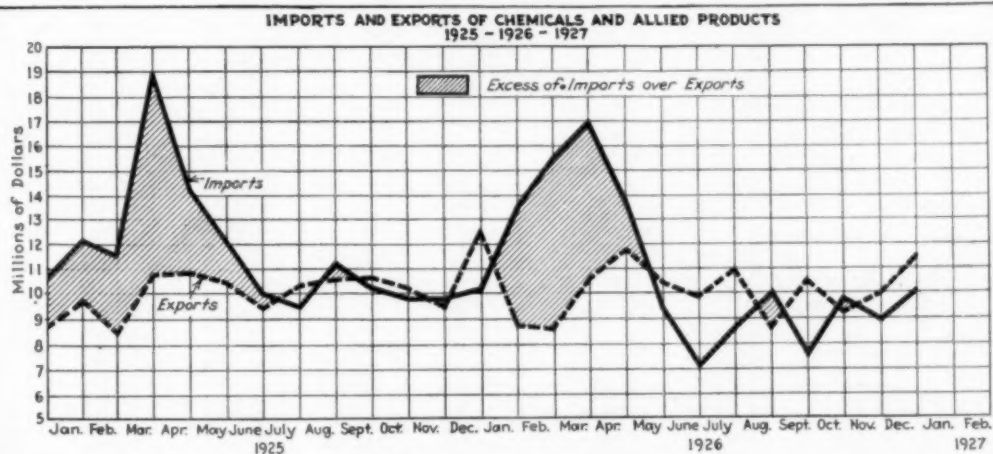
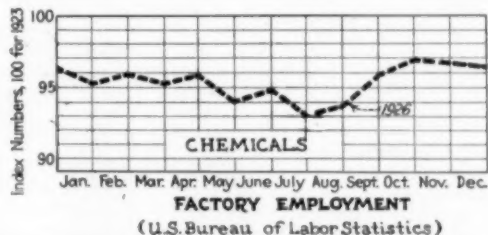
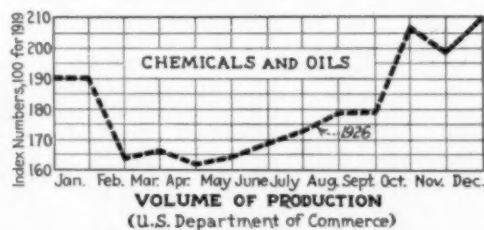
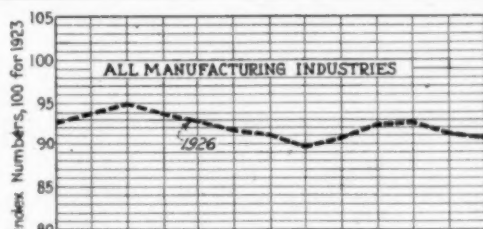
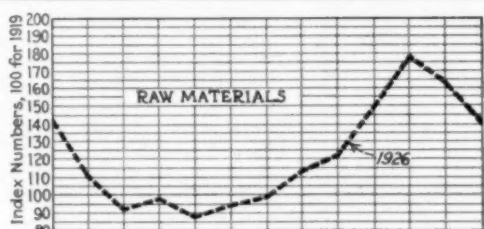
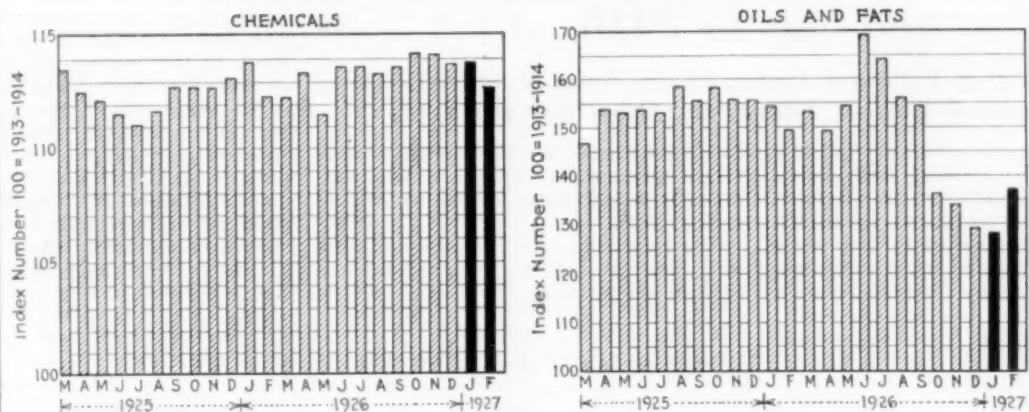
### Alsace Potash Production Shows Large Increase

Potash production in Alsace during the first ten months of 1926 amounted to 1,877,300 metric tons, yielding 299,000 tons of pure potash as compared with 250,000 tons of pure potash for the same period in 1925 and 226,250 tons for 1924, according to advices from consul J. D. Johnson. Total production of crude salts in Alsace during 1926 is estimated at more than 2,300,000 tons which is an increase of nearly 20 per cent over the previous year and approximately seven times the production of 1918. Exports of Alsace potash products to the United States for the first eleven months of 1926 amounted to 318,579 tons. It is estimated that the total for 1926 will exceed the 1925 shipments by from \$400,000 to \$500,000 in value.

## CHEM. & MET. Statistics of Business

### In the Chemical Engineering Industries

#### CHEM. & MET. WEIGHTED INDEXES OF WHOLESALE PRICES





## Market Conditions and Price Trends

### Record Factory Consumption of Oils and Fats in 1926

#### Wider Distribution Followed Activity in the Soap, Textile, Leather, Paint and Varnish, Edible, and Other Industries

FACTORY consumption of vegetable, animal and fish oils, and animal fats, greases, and kindred products, during 1926, was the largest on record. The total of all these materials which entered into industry last year was more than 9.8 per cent larger than the

total consumed in 1925 with a still larger percentage of gain when compared with the totals for the years preceding 1925.

The relatively small amounts of soya bean and peanut oils consumed since 1922 is explained by the higher import

duty which went into effect in the latter year and thus placed these oils on a level above the parity of competing fats and oils. One of the striking features in the market for vegetable oils in the last two years has been the rapid increase in the use of palm vernel oil. Olive oil fats also have found a steadily increasing outlet due in large part to enlarged call from the soap trade. Despite the expansion in production of pyroxylin lacquers and varnishes unusually large amounts of China wood oil were consumed in the last two years.

#### FACTORY CONSUMPTION OF VEGETABLE OILS

	1926 Lb.	1925 Lb.	1924 Lb.	1923 Lb.	1922 Lb.	1921 Lb.	1920 Lb.	1919 Lb.
Cottonseed, crude	1,694,062,953	1,475,322,331	1,163,820,744	934,994,608	895,161,564	1,295,740,304	1,133,777,101	1,317,717,546
Cottonseed, refined	1,131,957,942	1,161,115,204	779,858,005	675,245,550	734,068,771	895,032,630	676,902,237	900,607,773
Peanut, crude	10,577,850	10,323,544	8,650,913	7,504,233	28,372,261	42,542,807	85,067,507	212,353,312
Peanut, refined	8,427,460	8,800,662	5,683,564	7,548,428	28,907,302	34,686,139	79,291,163	190,176,290
Coconut, crude	433,340,194	385,454,710	363,770,156	360,002,327	305,330,218	235,090,359	294,098,972	422,257,005
Coconut, refined	207,713,122	205,776,941	210,900,864	211,940,058	165,080,442	139,417,771	236,102,679	212,216,696
Corn, crude	120,345,318	102,189,998	114,161,763	103,068,067	106,097,173	71,898,447	89,633,917	90,767,427
Corn, refined	22,133,216	10,403,096	13,987,412	18,596,367	28,287,639	7,766,123	20,883,297	18,591,820
Soya bean, crude	17,035,262	11,328,771	10,749,346	19,341,400	17,570,440	28,822,307	120,084,529	224,635,361
Soya bean, refined	10,158,575	5,501,481	5,882,260	6,762,002	4,601,115	10,526,957	36,524,574	106,780,776
Olive, edible	2,439,232	2,345,817	2,862,295	2,157,778	3,678,416	2,514,468	2,001,435	1,498,884
Olive, inedible	8,883,212	5,676,669	4,603,371	4,380,275	2,383,382	807,079	1,120,928	1,011,841
Olive, foots	35,636,606	28,963,212	22,197,514	24,831,718	22,190,152	11,546,001	6,369,313	3,196,464
Palm-kernal, crude	76,239,147	50,990,646	5,361,849	4,529,899	1,922,941	2,657,821	1,334,017	1,764,671
Palm-kernal, refined	6,927,145	4,416,658	206,198	398,354	194,372	1,838,730	335,651	244,038
Rapeseed	15,911,047	11,478,552	12,200,129	11,439,298	10,159,389	7,445,428	11,127,280	10,110,674
Linseed	414,947,640	413,942,837	381,407,503	381,245,301	344,362,688	242,721,325	214,203,046	189,145,649
China wood	85,309,427	87,881,315	70,529,915	72,333,664	62,855,998	35,965,800	46,381,235	34,166,655
Castor	18,286,350	16,304,612	14,813,229	16,733,979	12,075,138	6,442,055	6,527,908	5,642,505
Palm	121,960,733	109,824,921	78,656,193	114,385,473	43,961,819	22,826,725	24,791,212	18,450,532
Other	9,465,335	6,826,252	6,861,275	13,630,645	2,765,367	4,908,825	6,304,926	9,415,123
Totals	4,451,757,766	4,114,868,129	3,277,164,498	2,991,069,424	2,820,026,587	3,101,189,101	3,092,862,937	3,970,751,042

#### FACTORY CONSUMPTION OF FISH AND ANIMAL OILS

	1926 Lb.	1925 Lb.	1924 Lb.	1923 Lb.	1922 Lb.	1921 Lb.	1920 Lb.	1919 Lb.
Cod and cod-liver	14,155,969	12,281,149	11,585,447	11,736,936	15,273,866	8,347,417	3,683,011	4,624,070
Menhaden	39,902,441	48,473,310	34,288,576	55,373,236	36,135,978	60,693,254	20,701,869	16,357,473
Whale	61,674,956	52,661,795	40,454,865	38,302,824	51,141,796	5,621,410	17,826,827	9,606,631
Herring and sardine	22,422,246	31,859,086	26,228,036	11,098,945	4,775,585	951,887	1,054,568	2,732,954
Sperm	1,068,977	1,573,918	1,128,341	1,150,223	1,467,247	1,820,025	1,859,585	1,527,879
All other fish	5,383,301	7,474,665	2,581,104	1,038,235	1,257,627	2,526,783	3,059,850	4,313,830
Oleo	48,960,261	48,196,371	49,703,440	50,813,353	54,697,790	45,255,678	65,732,832	72,935,413
Lard	19,655,079	21,479,088	18,859,517	20,429,142	14,708,872	9,104,518	9,653,759	10,250,962
Tallow	9,203,569	8,129,671	34,864,475	28,942,021	33,297,616	30,065,402	39,815,401	49,984,263
Red	23,156,342	24,942,736	24,175,514	30,238,973	23,416,652	20,666,631	17,533,530	21,896,062
Neatsfoot	6,362,442	5,877,586	6,321,808	6,743,461	7,644,788	3,509,222	1,268,490	2,579,634
Totals	251,945,583	262,949,375	250,191,123	255,867,349	243,817,837	188,662,227	182,189,992	196,799,191

#### FACTORY CONSUMPTION OF ANIMAL FATS, GREASES, ETC.

	1926 Lb.	1925 Lb.	1924 Lb.	1923 Lb.	1922 Lb.	1921 Lb.	1920 Lb.	1919 Lb.
Lard, neutral	23,581,689	26,096,239	29,770,088	31,230,340	29,344,859	29,490,281	44,590,390	70,714,145
Lard, other edible	12,942,268	14,548,792	21,226,673	25,353,148	28,837,168	110,037,581	223,376,745	218,998,530
Tallow, edible	44,389,840	38,850,912	33,684,686	34,765,963	26,418,921	23,587,483	17,049,020	22,598,613
Tallow, inedible	507,481,971	478,960,645	516,440,781	465,868,998	463,925,337	398,670,773	310,818,343	262,341,486
Grease, white	27,490,084	24,858,880	45,217,261	59,727,341	51,469,261	38,947,944	46,769,399	51,981,416
Grease, yellow	67,824,273	78,401,045	60,040,415	57,083,050	56,380,038	36,423,957	42,274,025	35,912,771
Grease, brown	30,142,209	27,345,821	29,029,523	39,683,343	36,254,652	31,820,237	40,436,152	39,316,615
Grease, bone	1,641,089	748,466	1,880,772	1,733,618	3,273,242	3,214,920	5,982,975	9,672,845
Grease, tankage	2,635,328	2,388,157	2,772,305	2,519,355	2,000,410	4,363,201	7,951,781	7,436,325
Grease, house	89,205,669	86,099,232	85,911,889	80,527,625	76,217,108	45,867,605	38,298,524	47,563,784
Grease, wool	5,604,159	4,254,402	4,603,045	3,630,245	2,753,121	1,544,301	1,955,278	1,592,023
Grease, recovered	6,484,635	8,174,539	10,016,349	12,574,334	11,463,922	9,255,400	7,489,019	8,067,567
Grease, other	5,817,967	7,569,521	6,556,863	10,165,137	6,379,605	5,861,511	9,933,410	4,718,252
Lard compound	596,182	1,122,359	1,866,138	1,814,657	1,458,997			
Hydrogenated oils	420,073,126	390,800,932	277,762,611	263,405,140	242,322,673	59,279,181	35,119,614	53,391,181
Stearin, vegetable	16,817,289	20,800,236	17,872,411	14,346,890	14,716,144	24,072,721	19,452,817	32,586,358
Stearin, animal, edible	56,703,446	60,493,204	55,093,965	49,589,575	52,023,351	42,918,005	48,901,313	47,253,920
Stearin, animal, inedible	18,417,696	22,623,323	25,281,932	22,618,369	18,083,714	17,235,134	18,539,481	28,060,502
Fatty acids	170,207,069	131,471,306	110,414,141	104,525,487	100,435,819	72,164,444	52,666,784	50,509,190
Fatty acids, dist.	68,850,184	73,181,089	94,203,896	38,354,834	44,751,866	64,457,073	67,677,423	49,361,875
Stearic acid	10,961,710	10,190,231	11,459,315	9,939,707	7,032,033	5,615,879	6,319,353	5,567,664
Glycerine, crude	135,798,943	122,023,866	105,991,503	99,766,352	84,708,496	57,364,402	62,515,030	58,974,041
Glycerine, dynamite	35,466,709	47,457,861	36,554,914	50,580,139	29,681,961	31,997,374	37,720,333	28,961,873
Glycerine, C. P.	5,805,631	5,810,188	5,227,247	5,262,012	4,978,883	4,927,536	2,714,350	1,745,538
Cottonseed foots	267,453,865	179,581,750	122,801,811	109,345,753	95,536,736	141,650,070	163,816,548	171,078,556
Cottonseed foots, dist.	168,104,904	95,091,411	61,141,305	37,377,304	28,075,362	7,967,232	23,365,565	27,673,913
Other vegetable foots	43,173,834	32,843,277	36,325,476	27,699,379	27,562,301	20,158,844	33,465,629	43,286,964
Other vegetable foots, dist.	1,372,267	92,963	963,830	746,966	819,935	326,944	224,557	
Acidulated soap stock	94,737,504	41,613,029	25,705,130	17,494,440	29,207,006	51,219,347	74,903,951	47,312,329
Chinese vegetable tallow	3,040,407	8,328,592	6,630,522	5,562,327	4,086,666	2,876,501	3,157,215	3,654,682
Miscellaneous soap stock	6,464,183	4,724,750	5,348,095	8,147,272	9,469,374	23,279,901	36,018,552	33,983,892
Totals	2,349,286,130	2,046,547,018	1,847,794,892	1,691,439,100	1,589,668,961	1,366,795,782	1,483,503,576	1,464,717,050
Grand totals	7,052,989,479	6,424,364,522	5,375,150,513	4,938,375,873	4,653,513,385	4,656,647,110	4,758,556,505	5,632,267,283

## Market Conditions and Price Trends

### Price Protection Clause Stimulates Nitrate of Soda Trade

#### Buying Orders Increase and Oficinas Plan To Re-open—Meat Packing Offers Outlet for Nitrite of Soda

REPORTS were received the latter part of January by the Department of Commerce to the effect that a price decline protection that importers of Chilean nitrate sought from the Nitrate Producers' Association during the series of conferences held in Valparaiso early in July, 1926, has been granted in a somewhat different form than has been in effect in contracts made during previous years.

It has been announced that the directorate of the Association has been empowered to sell up to 400,000 tons of nitrate of soda at 19 shillings 9 pence per metric quintal between January 20 and May 31, 1927, guaranteeing buyers to repurchase 75 per cent of any portion of these stocks remaining unsold in their possession after June 30, 1927. Nitrate repurchased under this guarantee will be paid for on the basis of 19 shillings 9 pence per metric quintal plus ocean freights, marine insurance, unloading and handling charges. It will be optional for any producer to participate in the supply of 400,000 tons of nitrate sold subject to repurchase guarantee, and only those sharing in the sales are obligated by the terms of the guarantee. The sales price announced for the material to be sold subject to repurchase guarantee; namely, 19 shillings 9 pence per quintal, is the same price as was fixed at the beginning of the present nitrate year for deliveries during the period, January 1 to May 31, 1927.

The effect of this was apparent in a later communication from Chile which stated that at the end of last year there were only 30 nitrate plants operating. Since the price guarantee was issued several plants have planned to reopen.

Production of nitrate in Chile in December fell off to 86,731 metric tons which was the lowest monthly total for the year. Prospects for lower prices for nitrate in the future are favorable as according to reports German-owned plants have announced that sales will be without restrictions after July 1 which means that the schedule of the producers association will not be ad-

hered to. In fact the dissolution of the association is regarded as certain. This will give an advantage to the plants of low-cost operation.

#### Larger Consuming Field for Nitrite of Soda

The Department of Agriculture recently issued a statement relative to the value of nitrite of soda in meat curing. The statement said that important discoveries in the chemistry of meat curing by Robert H. Kerr and associates in the Federal meat-inspection laboratories appear to have wide significance. Though the art of curing meats by salts has been practiced from remote antiquity, only in recent years has the function of the salts known as nitrates been correctly understood. The chief value of nitrates in meat curing is to fix the color and this occurs through a reduction of nitrate to nitrite and the combination of the latter with the hemoglobin of the meat. The nitrates themselves are without value as color fixatives and become active only when reduced to nitrites.

Since sodium and potassium nitrites are well-known chemicals, it appeared fully as feasible to use the nitrite directly as to await the customary reduction of the nitrates. Accordingly, the department granted permission to an establishment operating under Federal meat inspection to conduct experiments on a commercial scale under the supervision of the Federal Meat Inspection Service. The results were highly satisfactory and nitrite of soda was given official sanction as a material to be used in the curing of meats. As the use of nitrite is said to shorten the curing process from 10 to 50 per cent of the former curing period and as the quantity of nitrite can be more accurately controlled by direct use, it is expected that preference will be given to the latter and that considerable quantities will be used by meat curers during the present year.

While imports of nitrite of soda were small during December the market in recent weeks has found importers active on the selling side and prices have been unsteady.

#### Prussiate of Soda Held at Advanced Levels

For several months there has been an absence of selling pressure in the market for prussiate of soda. Shipments from foreign producing countries have fallen off in volume and domestic sellers have been in command of the mar-

ket. Imports in December amounted to 55,878 lb. as compared with arrivals of 260,350 lb. in December, 1925. For the year there was a decline in imports of more than 50 per cent, the totals being 814,891 lb. in 1926 and 1,636,894 lb. in 1925. Offerings for future shipment from abroad also are reported to be limited and the result is seen in the firm price position which the market now maintains. Spot holdings of both imported and domestic makes are either very small or are in strong hands with 12c. per lb. quoted as the minimum figure at which orders may be placed. Foreign markets are reported to be above the parity of domestic prices and the present price situation appears to be more than temporary.

#### Exports of Chemicals

	December 1925	1926
Benzol, lb.	6,006,330	22,674,946
Aniline oil and salt, lb.	75,728	71,838
Acid, acetic, lb.	41,010	35,852
Acid, sulphuric, lb.	581,442	638,607
Acid, boric, lb.	41,519	78,301
Methanol, gal.	73,092	8,704
Ammonia and compounds, lb.	464,836	695,743
Aluminum sulphate, lb.	4,133,056	3,253,967
Acetate of lime, lb.	2,969,651	674,620
Calcium carbide, lb.	173,365	271,025
Bleaching powder, lb.	1,693,944	1,140,576
Copper sulphate, lb.	1,605,782	297,432
Formaldehyde, lb.	493,127	236,684
Potassium bichromate, lb.	41,107	10,986
Sodium bichromate, lb.	963,739	887,799
Sodium cyanide, lb.	201,204	175,055
Borax, lb.	2,946,577	1,863,843
Soda ash, lb.	2,935,510	3,524,303
Sodium silicate, lb.	3,995,227	3,494,392
Sal soda, lb.	838,258	687,834
Caustic soda, lb.	11,998,182	11,225,146
Bicarbonate of soda, lb.	983,379	1,440,251
Sulphate of ammonia, ton.	12,413	15,502
Sulphur, ton.	58,176	45,301

#### Imports of Chemicals

	December 1925	1926
Dead or creosote oil, gal.	4,274,998	3,313,429
Pyridine, lb.	69,596	24,911
Arsenic, lb.	470,410	354,744
Acid, citric, lb.	11,200	.....
Acid, formic, lb.	87,486	236,808
Acid, oxalic, lb.	85,267	102,173
Acid, sulphuric, lb.	3,858,131	2,867,367
Acid, tartaric, lb.	16,576	78,400
Ammonium chloride, lb.	1,003,587	2,521,271
Ammonium nitrate, lb.	1,179,776	1,327,558
Barium compounds, lb.	1,486,496	1,059,664
Calcium carbide, lb.	2,739,955	1,662,155
Copper sulphate, lb.	336,126	144,197
Bleaching powder, lb.	94,047	585,273
Magnesium compounds, lb.	1,885,228	1,970,520
Potassium cyanide, lb.	203,747	3,478
Potassium carbonate, lb.	618,929	881,182
Potassium hydroxide, lb.	881,409	1,271,297
Potassium chlorate, lb.	156,911	978,180
Sodium cyanide, lb.	2,338,735	2,067,556
Sodium nitrite, lb.	781,620	20,334
Sodium nitrate, ton.	43,018	63,660
Sulphate of ammonia, ton.	.....	.....

#### Chem. & Met. Weighted Index of Chemical Prices

Base = 100 for 1913-14

This month	112.79
Last month	113.76
February, 1926	112.32
February, 1925	113.63

Lower prices for carbonate of lead, other lead salts, alcohol, sulphate of ammonia and miscellaneous chemicals caused a further recession in the weighted index number.

#### Chem. & Met. Weighted Index of Prices for Oils and Fats

Base = 100 for 1913-14

This month	137.14
Last month	127.35
February, 1926	152.43
February, 1925	148.33

Increases in sales prices for vegetable oils extended practically throughout the entire list and this combined with higher markets for animal fats was responsible for a sharp upward movement of the weighted index number.



# Current Prices in the New York Market

## For Chemicals, Oils and Allied Products

The following prices refer to round lots in the New York Market. Where it is the trade custom to sell f.o.b. works, quotations are given on that basis and are so designated. Prices are corrected to February 14.

### Industrial Chemicals

	Current Price	Last Month	Last Year
Acetone, drums.....lb.	\$0.12-\$0.13	\$0.12-\$0.13	\$0.12-\$0.13
Acid, acetic, 28%, bbl.....cwt.	3.38-3.63	3.38-3.63	3.25-3.50
Boric, bbl.....lb.	0.81-0.83	0.81-0.83	0.81-0.83
Citric, kegs.....lb.	44-44	44-44	43-47
Formic, bbl.....lb.	11-11	10-11	10-10
Gallie, tech., bbl.....lb.	50-55	50-55	45-50
Hydrofluoric 30% carb.....lb.	0.6-0.7	0.6-0.7	0.6-0.7
Lactic, 44%, tech., light, bbl.....lb.	13-14	13-14	13-14
22%, tech., light, bbl.....lb.	0.6-0.7	0.6-0.7	0.6-0.7
Muriatic, 18%, tanks.....cwt.	85-90	85-90	80-85
Nitric, 36%, carboys.....cwt.	0.5-0.51	0.5-0.51	0.5-0.51
Oleum, tanks, wks.....ton	18.00-20.00	18.00-20.00	16.00-17.00
Oxalic, crystals, bbl.....lb.	11-11	11-11	10-11
Phosphoric, tech., c'ys.....lb.	0.7-0.71	0.7-0.71	0.7-0.8
Sulphuric, 60%, tanks.....ton	10.50-11.00	10.50-11.00	8.50-9.50
Tannic, tech., bbl.....lb.	35-40	35-40	45-50
Tartaric, powd., bbl.....lb.	2.91-3.0	2.8-3.0	2.7-3.0
Tungstic, bbl.....lb.	1.00-1.20	1.00-1.20	1.00-1.20
Alcohol, ethyl, 190 p.f. U.S.P. bbl.....gal.	4.92-5.00	4.90-5.00	4.94-5.04
Alcohol, Butyl, dr.....lb.	1.91-1.94	1.9-2.0	1.9-2.0
Denatured, 190 proof			
No. 1 special dr.....gal.	33-35	31-36	36-
No. 5, 188 proof, dr.....gal.	33-35	31-33	36-
Alum, ammonia, lump, bbl.....lb.	0.31-0.4	0.31-0.4	0.31-0.4
Chrome, bbl.....lb.	0.51-0.52	0.51-0.52	0.51-0.6
Potash, lump, bbl.....lb.	0.21-0.31	0.21-0.31	0.21-0.31
Aluminum sulphate, com., bags.....cwt.	1.40-1.45	1.40-1.45	1.40-1.45
Iron free, bg.....cwt.	2.00-2.10	2.00-2.10	2.40-2.45
Aqua ammonia, 26%, drums.....lb.	0.21-0.3	0.21-0.31	0.31-0.4
Ammonia, anhydrous, cyl.....lb.	11-13	11-15	15-17
Ammonium carbonate, powd., tech., casks.....lb.	10-14	10-14	11-14
Sulphate, wks.....cwt.	2.47-2.50	2.50-2.50	2.90-3.00
Amylacetate tech., drums.....gal.	2.15-2.20	2.15-2.20	2.30-2.40
Antimony Oxide, bbl.....lb.	16-17	15-16	18-19
Arsenic, white, powd., bbl.....lb.	0.31-0.41	0.31-0.41	0.31-0.41
Red, powd., kegs.....lb.	10-11	10-11	12-12
Barium carbonate, bbl.....ton	47.00-50.00	50.00-52.00	43.00-45.00
Chloride, bbl.....ton	62.00-65.00	62.00-65.00	58.00-60.00
Nitrate, cask.....lb.	0.71-0.8	0.71-0.81	0.71-0.8
Blanc fixe, dry, bbl.....lb.	0.4-0.41	0.41-0.4	0.31-0.4
Bleaching powder, f.o.b., wks., drums.....cwt.	2.00-2.10	2.00-2.10	2.00-2.10
Borax, bbl.....lb.	0.41-0.44	0.41-0.5	0.5-0.51
Bromine, cs.....lb.	45-47	45-47	45-47
Calcium acetate, bags.....cwt.	3.50-	3.50-	5.25-3.50
Arsenate, dr.....lb.	0.61-0.8	0.61-0.7	0.7-0.8
Carbide drums.....lb.	0.51-0.6	0.51-0.6	0.5-0.51
Chloride, fused, dr., wks.....ton	21.00-	21.00-	21.00-
Phosphate, bbl.....lb.	0.7-0.71	0.7-0.71	0.7-0.71
Carbon bisulphide, drums.....lb.	0.51-0.6	0.51-0.6	0.6-0.61
Tetrachloride drums.....lb.	0.61-0.7	0.61-0.61	0.61-0.7
Chlorine, liquid, tanks, wks.....lb.	0.4-0.41	0.4-0.41	0.4-0.41
Cylinders.....lb.	0.51-0.8	0.51-0.8	0.51-0.8
Cobalt oxide, cans.....ton	2.00-2.10	2.10-2.20	2.10-2.25
Copperas, f.o.b., wks.....ton	15.00-16.00	16.00-18.00	13.50-14.00
Copper carbonate, bbl.....lb.	17-171	17-18	17-18
Cyanide, tech., bbl.....lb.	49-50	49-50	49-50
Sulphate, bbl.....cwt.	4.80-4.90	4.80-4.90	4.50-4.60
Cream of tartar, bbl.....lb.	22-221	21-22	21-22
Epsom salt, dom., tech., bbl.....cwt.	1.75-2.15	1.75-2.00	1.75-2.00
Imp., tech., bags.....cwt.	1.15-1.25	1.15-1.25	1.35-1.40
Ethyl acetate, 85% drums.....gal.	74-76	74-76	80-82
99%, dr.....lb.	1.03-	95-96	1.03-1.08
Formaldehyde, 40%, bbl.....lb.	11-111	11-111	0.9-0.91
Furfural, dr.....lb.	15-171	15-171	20-23
Fusel oil, crude, drums.....gal.	1.35-1.40	1.40-1.50	1.80-1.90
Refined, dr.....gal.	2.50-3.00	2.50-3.00	3.10-3.20
Glauber's salt, bags.....cwt.	1.00-1.15	1.00-1.10	1.20-1.40
Glycerine, c.p., drums, extra.....lb.	28-281	29-30	25-26
Lead:			
White, basic carbonate, dry, casks.....lb.	0.91-	1.01-	1.01-
White, basic sulphate, sek.....lb.	0.91-	0.91-	1.01-
Red, dry, sek.....lb.	1.01-	1.11-	1.21-
Lead acetate, white crys., bbl.....lb.	14-15	14-15	14-15
Lead arsenate, powd., bbl.....ton	14-15	14-15	14-15
Lime, chem., bulk.....lb.	8.50-	8.50-	8.50-
Litharge, powd., csk.....lb.	101-	11-	111-
Lithopone, bags.....lb.	0.51-0.6	0.51-0.6	0.6-0.61
Magnesium carb., tech., bags.....lb.	0.71-0.8	0.71-0.8	0.61-0.7
Methanol, 95%, dr.....gal.	85-	85-	57-60
97%, dr.....gal.	90-	90-	59-63
Nickel salt, double, bbl.....lb.	10-101	10-101	0.9-10
Single, bbl.....lb.	101-11	101-11	10-11
Orange mineral, csk.....lb.	13-	131-	14-
Phosphorus, red, cases.....lb.	62-65	62-65	68-70
Yellow, cases.....lb.	32-33	32-34	34-36
Potassium bichromate, casks.....lb.	0.81-0.81	0.81-0.81	0.81-0.81
Carbonate, 80-85%, calc., csk.....lb.	0.51-0.6	0.6-0.61	0.6-0.61
Chlorate, powd.....lb.	0.81-0.9	0.81-0.9	0.81-0.9
Cyanide, cs.....lb.	55-57	55-58	52-54

	Current Price	Last Month	Last Year
First sorts, csk.....lb.	\$0.09-\$0.091	\$0.081-\$0.09	\$0.081-\$0.081
Hydroxide (caustic potash) dr.....lb.	0.71-0.71	0.71-0.71	0.71-0.71
Muriate, 80% bgs.....ton	36.40-	36.40-	34.90-
Nitrate, bbl.....lb.	0.6-0.61	0.6-0.61	0.6-0.71
Permanganate, drums.....lb.	14-15	14-15	14-15
Prussiate, yellow, casks.....lb.	181-19	19-191	18-181
Sal ammoniac, white, casks.....lb.	0.51-0.6	0.51-0.61	0.51-0.6
Salsoda, bbl.....cwt.	90-95	90-95	110-120
Salt cake, bulk.....ton	17.00-18.00	17.00-18.00	17.00-19.00
Soda ash, light, 58%, bags, contract.....cwt.	1.321-	1.38-	1.38-
Dense, bags.....cwt.	1.371-	1.45-1.55	1.45-1.55
Soda, caustic, 76%, solid, drums, contract.....cwt.	3.00-	3.10-	3.10-
Acetate, works, bbl.....lb.	0.41-0.51	0.41-0.5	0.41-0.5
Bicarbonate, bbl.....cwt.	2.00-2.25	2.00-2.25	1.75-2.00
Bichromate, casks.....lb.	0.61-0.61	0.61-0.61	0.61-0.61
Bisulphate, bulk.....ton	5.00-5.50	5.00-5.50	6.00-7.00
Bisulphite, bbl.....lb.	0.31-0.4	0.31-0.4	0.41-0.41
Chlorate, kegs.....lb.	0.61-0.61	0.61-0.61	0.61-0.61
Chloride, tech.....ton	12.00-14.75	12.00-14.75	12.00-14.00
Cyanide, cases, dom.....ton	18-22	18-22	19-22
Fluoride, bbl.....lb.	0.91-0.91	0.9-0.91	0.9-0.91
Hyposulphite, bbl.....lb.	2.50-3.00	2.50-3.00	0.21-0.21
Nitrate, bags.....cwt.	2.63-	2.63-	2.421-
Nitrite, casks.....lb.	0.81-0.91	0.81-0.9	0.9-0.91
Phosphate, dibasic, bbl.....lb.	0.31-0.31	0.31-0.31	0.31-0.31
Prussiate, yel. drums.....lb.	11-111	101-101	101-101
Silicate (30%, drums).....cwt.	75-115	75-115	75-115
Sulphide, fused, 60-62%, dr.....lb.	0.3-0.31	0.3-0.31	0.21-0.3
Sulphite, crys., bbl.....lb.	0.3-0.31	0.3-0.31	0.21-0.3
Strontium nitrate, bbl.....lb.	0.81-0.9	0.81-0.9	0.91-10
Sulphur, crude at mine, bulk.....ton	19.00-	19.00-	15.00-17.00
Chloride, dr.....lb.	0.4-0.5	0.4-0.5	0.4-0.5
Dioxide, cyl.....lb.	0.9-10	0.9-10	0.81-0.9
Flour, bag.....cwt.	2.70-3.00	2.70-3.00	2.25-2.35
Tin bichloride, bbl.....lb.	1.91-	1.91-	1.6-
Oxide, bbl.....lb.	68-	70-	39-
Crystals, bbl.....lb.	47-	46-	39-
Zinc chloride, gran., bbl.....lb.	0.61-0.61	0.7-0.7	0.6-0.71
Carbonate, bbl.....lb.	10-11	11-111	12-14
Cyanide, dr.....lb.	40-41	40-41	40-41
Dust, bbl.....lb.	10-101	0.9-10	0.8-0.81
Zinc oxide, lead free, bag.....lb.	0.61-	0.71-	0.71-
5% lead sulphate, bags.....lb.	0.61-	0.7-	0.61-
Sulphate, bbl.....cwt.	2.75-3.00	2.75-3.00	3.50-3.75

### Oils and Fats

	Current Price	Last Month	Last Year
Castor oil, No. 3, bbl.....lb.	\$0.13-\$0.131	\$0.13-\$0.131	\$0.141-\$0.15
China wood oil, bbl.....lb.	171-18	15-	13-131
Cocoon oil, Ceylon, tanks, N. Y.....lb.	0.81-	0.81-	1.01-
Corn oil crude, tanks, (f.o.b. mill).....lb.	0.8-	0.71-	0.91-
Cottonseed oil, crude (f.o.b. mill), tanks.....lb.	0.71-	0.7-	0.91-
Linseed oil, raw, car lots, bbl.....lb.	10.4-	10.5-	11.2-
Palm, Lagos, casks.....lb.	0.81-0.9	0.81-0.81	0.9-
Niger, casks.....lb.	0.81-	0.71-0.8	0.81-
Palm Kernel, bbl.....lb.	0.91-	0.9-	1.0-1.01
Peanut oil, crude, tanks (mill).....lb.	1.21-	0.91-	1.0-
Perilla, bbl.....lb.	-	-	1.41-
Rapeseed oil, refined, bbl.....gal.	79-80	79-80	90-92
Sesame, bbl.....lb.	-	-	-
Soya bean tank (f.o.b. Coast).....lb.	0.91-	0.91-	1.01-
Sulphur (olive foot), bbl.....lb.	0.91-	0.91-	0.9-
Cod, Newfoundland, bbl.....gal.	63-66	63-64	64-65
Menhaden, light pressed, bbl.....gal.	60-62	58-60	69-71
Crude, tanks (f.o.b. factory).....gal.	-	45-	55-
Whale, crude, tanks.....lb.	-	-	-
Grease, yellow, loose.....lb.	0.61-	0.61-	0.81-0.81
Oleo stearine.....lb.	0.81-	0.81-	1.11-
Red oil, distilled, d.p. bbl.....lb.	0.91-10	0.91-10	1.11-1.11
Tallow, extra, loose.....lb.	0.71-	0.71-	0.91-

### Coal-Tar Products

	Current Price	Last Month	Last Year
Alpha-naphthol, crude, bbl.....lb.	\$0.60-\$0.65	\$0.60-\$0.65	\$0.60-\$0.62
Refined, bbl.....lb.	65-90	85-90	75-80
Alpha-naphthylamine, bbl.....lb.	35-36	35-36	35-36
Aniline oil, drums, extra.....lb.	15-16	16-161	17-171
Aniline salts, bbl.....lb.	24-25	22-24	20-22
Anthracene, 80%, drums.....lb.	60-65	60-65	65-70
Benzaldehyde, U.S.P., dr.....lb.	1.15-1.25	1.15-1.35	1.50-
Benzidine base, bbl.....lb.	70-72	70-75	78-81
Benzoic acid, U.S.P., kgs.....lb.	58-60	58-60	75-85
Benzyl chloride, tech, dr.....lb.	25-26	25-26	35-36
Benzol, 90%, tanks, works.....gal.	24-25	25-28	23-24
Beta-naphthol, tech., drums.....lb.	22-24	22-24	24-25
Cresol, U.S.P., dr.....lb.	18-20	18-20	23-25
Cresylic acid, 97%, dr., wks.....gal.	57-60	59-63	53-55
Diethylaniline, dr.....lb.	58-60	58-60	59-61
Dinitrophenol, bbl.....lb.	31-35	31-33	35-38
Dinitrotoluen, bbl.....lb.	17-18	17-18	18-20
Dip oil, 25% dr.....gal.	28-30	28-30	26-28
Diphenylamine, bbl.....lb.	45-47	48-50	48-50
H-acid, bbl.....lb.	63-65	63-65	70-74

## Coal-Tar Products—Continued

	Current Price	Last Month	Last Year
Naphthalene, flake, bbl. .... lb.	\$0.051-\$0.06	\$0.051-\$0.06	\$0.05-\$0.051
Nitrobenzene, dr. .... lb.	.09 - .10	.09 - .10	.09 - .10
Para-nitraniline, bbl. .... lb.	.52 - .53	.45 - .50	.65 - .67
Para-nitrotoluene, bbl. .... lb.	.28 - .32	.28 - .32	.40 - .42
Phenol, U.S.P., drums .... lb.	.17 - .19	.17 - .19	.23 - .25
Picric acid, bbl. .... lb.	.30 - .40	.30 - .40	.25 - .26
Pyridine, dr. .... lb.	3.00 - .	3.00 - .	4.10 - 4.20
R-salt, bbl. .... lb.	.47 - .50	.40 - .44	.50 - .55
Resorcinol, tech, kegs. .... lb.	1.30 - 1.35	1.35 - 1.40	1.30 - 1.40
Salicylic acid, tech, bbl. .... lb.	.30 - .32	.30 - .32	.32 - .33
Solvent naphtha, w.w., tanks, gal.	.35 - .	.35 - .	.35 - .
Tolidine, bbl. .... lb.	.95 - .95	.95 - .96	1.00 - 1.05
Toluene, tanks, works. .... gal.	.35 - .	.35 - .	.26 - .
Xylene, com., tanks .... gal.	.36 - .41	.36 - .41	.31 - .

## Miscellaneous

	Current Price	Last Month	Last Year
Barytes, grd., white, bbl. .... ton	\$23.00-\$25.00	\$23.00-\$25.00	\$20.00-\$22.00
Casein, tech., bbl. .... lb.	.15 - .16	.15 - .16	.13 - .14
China clay, dom. f.o.b. mine ton	10.00 - 20.00	10.00 - 20.00	10.00 - 20.00
Dry colors:			
Carbon gas, black (wks.) lb.	.08 - .081	.08 - .081	.07 - .071
Prussian blue, bbl. .... lb.	.33 - .34	.33 - .34	.34 - .36
Ultramarine blue, bbl. .... lb.	.08 - .35	.08 - .35	.08 - .35
Chrome green, bbl. .... lb.	.27 - .31	.28 - .30	.27 - .29
Carmine red, tins. .... lb.	5.00 - 5.10	5.00 - 5.10	4.50 - 4.75
Para toner. .... lb.	.80 - .90	.80 - .90	.90 - .95
Vermilion, English, bbl. .... lb.	1.50 - 1.55	1.50 - 1.55	1.35 - 1.40
Chrome yellow, C. P., bbl. .... lb.	.17 - .18	.17 - .18	.18 - .19
Feldspar, No. 1 (f.o.b. N. C.) ton	5.50 - 6.50	6.00 - 6.50	5.50 - 6.00
Graphite, Ceylon, lump, bbl. .... lb.	.07 - .091	.07 - .091	.081 - .09
Gum copal, Congo, bags. .... lb.	.091 - .10	.091 - .10	.08 - .10
Manila, bags. .... lb.	.15 - .18	.15 - .16	.14 - .16
Damar, Batavia, cases. .... lb.	.25 - .251	.25 - .26	.281 - .281
Kauri, No. 1 cases. .... lb.	.55 - .57	.57 - .65	.58 - .62
Kieselguhr (f.o.b. N. Y.) .... ton	50.00 - 55.00	50.00 - 55.00	50.00 - 55.00
Magnesite, calc. .... ton	44.00 - .	44.00 - .	40.00 - 41.00
Pumice stone, lump, bbl. .... lb.	.05 - .07	.05 - .08	.06 - .08
Imported, casks. .... lb.	.03 - .40	.03 - .40	.03 - .35
Rosin, H. .... bbl.	12.85 - .	12.25 - .	14.50 - .
Turpentine. .... gal.	.76 - .	.88 - .	1.10 - .
Shellac, orange, fine, bags. .... lb.	.48 - .49	.48 - .49	.72 - .73
Bleached, bonedry, bags. .... lb.	.53 - .54	.53 - .54	.59 - .62
T. N. bags. .... lb.	.42 - .44	.43 - .45	.48 - .49
Soapstone (f.o.b. Vt.), bags. ton	10.00 - 12.00	10.00 - 12.00	9.00 - 11.00
Talc, 200 mesh (f.o.b. Vt.) ton	11.00 - .	11.00 - .	10.50 - .
200 mesh (f.o.b. Ga.) ton	7.50 - 10.00	7.50 - 10.00	7.50 - 11.00
325 mesh (f.o.b. N. Y.) ton	14.75 - .	14.75 - .	14.75 - 1
Wax, Bayberry, bbl. .... lb.	.25 - .26	.25 - .26	.20 - .21
Beeswax, ref., light. .... lb.	.45 - .46	.45 - .47	.40 - .42
Candelilla, bags. .... lb.	.33 - .34	.34 - .35	.30 - .31
Carnauba, No. 1, bags. .... lb.	.65 - .70	.70 - .72	.37 - .38
Paraffine, crude 105-110 m.p. .... lb.	.051 - .06	.06 - .061	.06 - .

## Ferro-Alloys

	Current Price	Last Month	Last Year
Ferrotitanium, 15-18% .... ton	\$200.00 - .	\$200.00 - .	\$200.00 - .
Ferrochromium, 1-2% .... lb.	.23 - .25	.23 - .35	.24 - .
Ferromanganese, 78-82% .... ton	100.00 - .	88.00-90.00	115.00 - .
Spiegeleisen, 19-21% .... ton	36.00-37.00	32.00-34.00	32.00 - .
Ferrosilicon, 10-12% .... ton	33.00-38.00	33.00-38.00	33.00-38.00
Ferrotungsten, 70-80% .... lb.	1.05 - .	1.00 - 1.05	1.14 - .
Ferro-uranium, 35-50% .... lb.	4.50 - .	4.50 - .	4.50 - .
Ferrovanadium, 30-40% .... lb.	3.15 - 3.75	3.25 - 4.00	3.25 - 3.75

## Non-Ferrous Metals

	Current Price	Last Month	Last Year
Copper, electrolytic. .... lb.	\$0.121 - .	\$0.131 - .	\$0.14 - \$0.14
Aluminum, 96-99% .... lb.	.26 - .28	.27 - .28	.28 - .29
Antimony, Chin. and Jap. .... lb.	.141 - .	.131 - .131	.201 - .
Nickel, 99% .... lb.	.35 - .	.35 - .	.34 - .
Monel metal, blocks. .... lb.	.32 - .33	.32 - .33	.32 - .33
Tin, 5-ton lots, Straits. .... lb.	.691 - .	.67 - .	.631 - .
Lead, New York, spot. .... lb.	7.30 - .	7.65 - .	.091 - .
Zinc, New York, spot. .... lb.	7.10 - .	7.35 - .	.091 - .
Silver, commercial. .... oz.	.561 - .	.551 - .	.691 - .
Cadmium .... lb.	.60 - .	.60 - .	.60 - .
Bismuth, 508-lb. lots. .... lb.	2.70 - 2.75	2.70 - 2.75	2.65 - 2.70
Cobalt. .... lb.	2.50 - .	2.50 - .	2.50 - 3.00
Magnesium, ingots, 99% .... lb.	1.00 - .80	.75 - .80	1.00 - .
Platinum, ref. .... oz.	112.00 - .	112.00 - .	120.00 - .
Palladium, ref. .... oz.	68.00 - 70.00	68.00 - 69.00	78.00 - .
Mercury, flask. .... 75 lb.	102.00 - .	101.00 - .	91.00 - .
Tungsten powder. .... lb.	1.05 - 1.15	1.05 - .	1.20 - .

## Ores and Semi-finished Products

	Current Price	Last Month	Last Year
Bauxite, crushed, wks. .... ton	\$5.50 - \$8.50	\$5.50 - \$8.50	\$5.50 - \$8.75
Chrome ore, c.f. post. .... ton	21.00 - 24.00	22.50 - 24.00	18.50 - 24.00
Coke, fdry., f.o.b. ovens. .... ton	3.75 - 4.25	3.75 - 4.25	4.75 - 5.00
Fluorspar, gravel, f.o.b. Ill. .... ton	18.00 - .	18.00 - .	17.50 - 18.50
Ilmenite, 52% TiO <sub>2</sub> , Va. .... lb.	.01 - .01	.011 - .	.011 - .
Manganese ore, 50% Mn., c.f. Atlantic Ports. .... unit	.36 - .38	.35 - .36	.42 - .43
Molybdenite, 85% MoS <sub>2</sub> per lb. MoS <sub>2</sub> , N. Y. .... lb.	.48 - .50	.48 - .50	.60 - .70
Monazite, 6% of ThO <sub>2</sub> .... ton	120.00 - .	120.00 - .	120.00 - .
Pyrites, Span. fines, c.f. .... unit	.131 - .	.131 - .	.111 - .12
Rutile, 94-96% TiO <sub>2</sub> .... lb.	.11 - .13	.12 - .15	.12 - .15
Tungsten, scheelite, 60% WO <sub>3</sub> and over. .... unit	11.25 - 11.50	12.50 - 13.00	9.50 - 9.75
Vanadium ore, per lb. V <sub>2</sub> O <sub>5</sub> .... lb.	.25 - .28	.25 - .30	1.00 - 1.27
Zircon, 99% .... lb.	.03 - .	.03 - .	.06 - .05

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Amer. Assn. of Cereal Chemists, Sec., R. K. Durham, 605 Huntzinger Bldg., Kansas City, Mo.

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- Cost Assn. of the Paper Industry. Sec.-Treas., Thomas J. Burke, 18 East 41st St., New York.
- Deutsche Chem. Ges. Sec., Dr. H. Jost, Sigismundstr. 4, Berlin, W. 10, Germany.
- Eastern Clay Products Assn. Sec., H. T. Shelley, 906 Colonial Trust Bldg., Philadelphia, Pa.
- Edible Gelatin Manufacturers Research Society of America, Inc. Sec., H. B. Sweatt, 1457 Broadway, New York.
- Enameled Sanitary Ware Mfrs. Assn. Sec., George D. McIlvaine, 909 Oliver Bldg., Pittsburgh, Pa.
- Engineering Foundation. Director, Alfred D. Flinn, 29 W. 39th St., New York.
- Engineering Inst. of Canada. Sec., R. J. Durley, 176 Mansfield St., Montreal, Que., Canada.
- Paraday Society. Sec., G. S. W. Marlow, 90 Great Russell St., London, W. C. 1, England.
- Franklin Inst. of the State of Pa. Sec., Howard McClenahan, 15 South 7th St., Philadelphia, Pa.
- Gas Products Assn. Sec. and Treas., James M. Cameron, 140 South Dearborn St., Chicago, Ill.
- Glass Container Assn. Sec., R. E. Walker, 22 East 75th St., New York.
- Gypsum Industries. Sec.-Treas., H. H. Macdonald, 844 Rush St., Chicago, Ill.
- Hawaiian Sugar Planters' Assn., Director, H. P. Agee, P. O. Box 411, Honolulu, Hawaii.
- Hydraulic Society, Inc., C. H. Rohrbach, Room 1506, 90 West St., New York, N. Y.
- Illuminating Engineering Society. Gen. Sec., L. H. Graves, 29 W. 39th St., New York.
- Industrial Alcohol Manufacturers Assn., Inc. Exec. Sec., Dr. Lewis H. Marks, 30 E. 42nd St., New York, N. Y.
- Insecticide & Disinfectant Mfrs. Assn., Inc. Sec., H. W. Cole, Holbrook, Mass.
- Institute of Amer. Meat Packers. Exec. Vice-Pres., W. W. Woods, 509 S. Wabash Ave., Chicago, Ill.
- Institute of Makers of Explosives. Sec., C. Stewart Comeaux, 103 Park Ave., New York.
- Institute of Margarin Manufacturers. Sec., Dr. J. S. Abbot, 1049 Munsey Bldg., Washington, D. C.
- Institute of Metals. Sec., G. Shaw Scott, 36 Victoria St., Westminster, London S. W. 1, England.
- Institute of Radio Engineers. Sec., Dr. Alfred N. Goldsmith, 37 West 39th St., New York.
- Institution of Chemical Engineers. Sec. Prof. J. W. Hinchley, Abbey House, Westminster, London, S. W. 1, England.
- Institution of Mining & Metallurgy, Sec., Charles McDermid, Cleveland House, 225 City Road, London, E. C. 1, England.
- Institution of Petroleum Technologists. Sec., Commander R. E. Stokes-Rees, Aldine House, Bedford St., Strand, London, W. C. 2, England.
- Instituto Científico e Industrial del Salitre. Gen. Sec., Belisario Diaz Ossa, Casilla 2730, Santiago, Chile.
- International Acetylene Assn., Sec., A. Cressy Morrison, 30 E. 42nd St., New York, N. Y.
- Interstate Cotton Seed Crushers' Assn., Inc., Sec., Geo. H. Bennett, 914-915 Santa Fe Bldg., Dallas, Tex.
- Inventors' League of the U. S., President, Geo. Whigelt, 5 Cedar St., New York.
- Iron & Steel Institute. Sec., G. C. Lloyd, 28 Victoria St., London, S. W. 1, England.
- Junior Institution of Engineers. Sec., Herbert G. Riddle, 39 Victoria St., Westminster, S. W. 1, England.
- Manufacturing Chemists Assoc. of the U. S. Sec., J. I. Tierney, 614 Investment Bldg., Washington, D. C.
- Metric Assn. Sec., Howard Richards, 156 5th Ave., New York.
- Mining & Metallurgical Soc. of Amer. Sec., Percy E. Barbour, 2 Rector St., New York.
- National Academy of Sciences. Sec., Dr. David White, National Academy of Sciences, 21 and B Sts., Washington, D. C.
- National Assn. of Cost Accountants. Sec., Stuart C. McLeod, 130 W. 42nd St., New York.
- National Assn. of Cotton Mfrs. Sec., Russell T. Fisher, 80 Federal St., Boston, Mass.
- National Assn. of Glue Mfrs. Inc. Sec., H. B. Sweatt, 1457 Broadway, New York.
- National Association of Importers of Hides & Skins, Inc. Exec. Sec., John R. Arnold, 15 Park Row, New York.
- National Assn. of Leather Belting Mfrs. Sec., George H. Blake, P. O. Box 859, City Hall Sta., New York.
- National Assn. of Mfrs. of Pressed & Blown Glassware. Sec., John Kunzler, House Bldg., Pittsburgh, Pa.
- National Assn. of Mfrs. Sec., George S. Boudinot, 50 Church St., New York.
- National Assn. of Practical Refrigerating Engrs. Sec., E. H. Fox, 5707 West Lake St., Chicago, Ill.
- National Assn. of Purchasing Agents. Sec., W. L. Chandler, Woolworth Bldg., New York.
- National Assn. of Sheet & Tin Plate Mfrs. Sec.-Treas., Walter W. Lower, 421 Oliver Bldg., Pittsburgh, Pa.
- National Assn. of Textile Dyers & Finishers. Exec. Sec., Frederick L. Babcock, 465 Main St., Cambridge, Mass.
- National Brick Manufacturers' Assn. Sec., Douglas F. Stevens, Acme Brick Co., Danville, Ill.
- National Cannery's Assn. Sec., Frank E. Gorrell, 1739 H Street, N.W., Washington, D. C.
- National Clay Products Industries Assn., Commissioner, H. A. Jung, 133 W. Washington St., Chicago, Ill.
- National Coal Assn. Exec. Sec., H. L. Gandy, 803 Southern Bldg., Washington, D. C.
- National Conference of Business Paper Editors. Sec., A. J. Fehrenbach, Class, 8 W. 40th St., New York.
- National Elec. Light Assn. Managing Director, Paul S. Clapp, 29 W. 39th St., New York.
- National Fertilizer Assn. Exec. Sec., Charles J. Brand, 616 Investment Bldg., Washington, D. C.
- National Fire Protection Assn. Sec., Franklin H. Wentworth, 40 Central St., Boston, Mass.
- National Foreign Trade Council. Sec., O. K. Davis, 1 Hanover Sq., New York.
- National Industrial Conference Board Inc. Sec., James M. Robertson, 247 Park Ave., New York.
- National Industrial Council. Sec., Michael J. Hickey 50 Church St., New York.
- National Lime Assn. Gen. Mgr., G. B. Arthur, 927-15th St., N. W., Washington, D. C.
- National Lumber Manufacturers Assn. Sec. & Mgr., Wilson Compton, Transportation Bldg., Washington, D. C.
- National Metal Trades Assn. Sec., J. E. Nyhan, 122 So. Michigan Ave., Chicago, Ill.
- National Paint, Oil & Varnish Assn. Inc. Gen. Mgr. G. V. Horgan, 18 East 41st St., New York.
- National Paving Brick Mfrs. Assn. Sec., Edward E. Duff, Jr., Engineers Bldg., Cleveland, Ohio.
- National Petroleum Assn. General Counsel, Mr. Fayette B. Dow, 930 Munsey Bldg., Washington, D. C.
- National Petroleum Marketers Assn. Sec., Miss Eva Arnstein, 624 S. Michigan Ave., Chicago, Ill.
- National Pipe & Supplies Assn. Sec., Geo. D. McIlvaine, 908 Oliver Bldg., Pittsburgh, Pa.
- National Research Council. Sec., Dr. Vernon Kellogg, B and 21st Sts., Washington, D. C.
- National Safety Council. Sec., W. H. Cameron, 108 East Ohio St., Chicago, Ill.
- National Wood Chemical Assn. Sec.-Treas., F. J. Goodfellow, 76 Main St., Bradford, Pa.
- Natural Gas Assn. of America. Sec., Guy F. Batchelor, 904 Oliver Bldg., Pittsburgh, Pa.
- New Jersey Chemical Society. Sec., Dr. Frederick W. Zons, 367 High St., Newark, N. J.
- New Jersey Clay Workers Assn. Sec., G. H. Brown, Ceramics Dept., Rutgers College, New Brunswick, N. J.
- New York Academy of Sciences. Sec., Dr. Ray Waldo Miner, 77th St. and Central Park West, New York City.
- Oil & Colour Chemists' Assn. Sec., James H. Aiken, 30 Russell Sq., London, W.C.1, England.
- Pine Institute of America, Inc. Sec.-Treas., Carl Wernicke, Gull Point, Fla.
- Plate Glass Mfrs. of Amer. Sec., P. A. Hughes, First National Bank Bldg., Pittsburgh, Pa.
- Portland Cement Assn. Sec.-Gen. Mgr., William M. Kinney, 33 W. Grand Ave., Chicago, Ill.
- Pyroxylin Plastics Manufacturers' Assn. Sec., Ralph R. Lounsbery, 350 Madison Ave., New York.
- Rubber Assn. of America. A. L. Viles, Gen. Mgr. and Sec., 250 West 57th St., New York.
- Rubber Growers' Assn., Inc. Frank G. Smith, Sec., 2, 3 and 4 Idol Lane, Eastcheap, London, E.C. 3, England.
- Salesmen's Assn. of the American Chemical Industry. Sec.-Treas., A. L. Benkert, c/o Noll Chemical & Color Works, 140 West 108th St., New York.
- Salt Producers Assn. Sec., D. B. Doremus, 1150 Penobscot Bldg., Detroit, Mich.

Sand-Lime Brick Assn. Sec., G. W. Phelps, Flint, Mich.  
Société de Chimie Industrielle. Sec., Jean Gerard, 49 Rue des Mathurins, Paris, France.

Society of Chemical Industry. Sec., Dr. J. P. Longstaff, 46 Finsbury Sq., London, E.C. 2, England.

Society of Chemical Industry (American Section). Sec., Foster D. Snell, Pratt Institute, Brooklyn, N. Y.

Society of Dyers & Colourists. Sec., J. B. Atkinson, Pearl Assurance Bldgs., Market St., Bradford, England.

Society of Glass Technology. Sec., Prof. W. E. S. Turner, Darnall Road, Sheffield, England.

Society of Industrial Engrs. Exec. Sec., George C. Dent, 608 S. Dearborn St., Chicago, Ill.

Society of Leather Trades Chemists. Sec., W. R. Atkin, University, Leeds, England.

Society for the Promotion of Engineering Education. Sec., Dean F. L. Bishop, University of Pittsburgh, Pittsburgh, Pa.

South African Chemical Institute. Hon. Sec., James Gray Scientific & Technical Club, 100 Fox St., Johannesburg, So. Africa.

South African Institution of Engrs. Inc. Sec., W. W. R. Jago, Box 4609, Johannesburg, So. Africa.

Steel Barrel Mfrs. Institute. Sec., D. S. Hunter, 809 Bulkley Bldg., Cleveland, Ohio.

Sugar Producers' Conference. Sec., E. W. Mayo, 135 Front St., New York.

Synthetic Organic Chem. Mfrs. Assn. of the U. S. President, Dr. August Merz, Room 343, 1 Madison Ave., New York.

Tanners' Council. Ass't Sec., J. L. Nelson, 41 Park Row, New York.

Taylor Society. Managing Director, Harlow S. Person, 29 W. 39th St., New York.

Technical Assn. of the Pulp & Paper Industry. Sec., W. G. MacNaughton, 18 E. 41st St., New York.

Technical Publicity Assn. Sec., B. H. Miller, Permutit Co., 440 Fourth Ave., New York.

Textile Alliance Inc., Pres., A. M. Patterson, 45 E. 17th St., New York.

Turpentine and Rosin Producers Assn. Sec., C. F. Speth, Whitney-Central Bldg., New Orleans, La.

Union Internationale de la Chimie Pure et Appliquée. Sec., Jean Gerard, 49 Rue des Mathurins, Paris, France.

United Engineering Society. Sec., Alfred D. Flinn, 29 W. 39th St., New York.

United States Alkali Export Assn., Inc., Sec.-Treas., H. M. Hooker, 25 Pine St., New York.

U. S. Beet Sugar Assn. Sec., Harry A. Austin, 901 Union Trust Bldg., Washington, D. C.

U. S. Potters Assn. Sec., Charles F. Goodwin, East Liverpool, Ohio.

U. S. Pulp Producers Assn. Sec., Oliver M. Porter, 18 E. 41st St., New York.

Washington Academy of Science. Sec., Dr. L. B. Tuckerman, Bureau of Standards, Washington, D. C.

Western Petroleum Refiners Assn. Managing Director, Howard Bennette, 504 Cosden Bldg., Tulsa, Okla.

## Current Industrial Developments

### New Construction and Machinery Requirements

**ALUM PLANT**—City, L. Day, Water Comr., St. Louis, Mo., is considering the construction of an alum manufacturing plant in connection with new waterworks at Howard's Bend on the Missouri River now under construction. Estimated cost \$60,000.

**ASBESTOS PLANT**—Wright Asbestos Mfg. Co., E. F. Wright, Wichita, Kan., is having preliminary plans prepared for the construction of an asbestos plant at Wichita Falls, Kan. Estimated cost \$45,000. Private plans. Complete equipment for the manufacture of asbestos and kindred products will be required.

**ASBESTOS PRODUCTS PLANT**—Eternit Inc., 8200 North Broadway, St. Louis, Mo., manufacturers of asbestos shingles, lumber, corrugated roofing and siding, awarded contract for the construction of a 1 story, 56 x 180 ft plant at 9049 Riverview Dr. to J. H. Bright Construction & Building Co., Arcade Bldg., St. Louis, Mo. Estimated cost \$450,000.

**BARBERS' SUPPLIES**—The Koken Companies, Inc., 2528 Texas Ave., St. Louis, Mo., awarded contract for the construction of a 1 story plant including dry kilns, etc., for the manufacture of barbers' supplies to W. H. Cunliff, 410 North Euclid Ave., St. Louis, Mo. Estimated cost \$160,000.

**BOTTLING PLANTS**—Delaware Punch Co., T. E. Lyons, 1619 North San Marcos St., San Antonio, Tex., plans the construction of a soft drink bottling plant at San Antonio. Estimated cost \$90,000. Private plans. Similar plants will be constructed at Dallas and Ft. Worth, Tex., Phoenix, Ariz., St. Louis and Kansas City, Mo. Complete machinery for all plants will be required. The company also voted a \$9,000,000 expansion program providing for erection of 1,200 bottling plants in the U. S. and foreign countries.

**BRASS FOUNDRY**—Universal Brass Works, 29th and Martindale Sts., Indianapolis, Ind., awarded contract for the construction of a 1 story, 102 x 163 ft. brass foundry to J. E. McGaughey, 322 American Central Life Bldg., Indianapolis, Ind. Estimated cost \$43,000.

**BREWERY**—Springbank Brewery Co., S. W. Barber, Mgr., Guelph, Ont., is having plans prepared for extensions and improvements to brewery to increase the capacity. Estimated cost \$50,000. Equipment will be required.

**BRICK PLANT**—Frontenac Brick Co., East Beauport, Que., P. A. Gelameau, Pres. and Gen. Mgr., is having plans prepared for the construction of a brick plant. Estimated cost \$1,000,000.

**BRICK (FIRE) PLANT**—Anso Fire Brick Co., E. M. Smith, Pres., of Pacific National Bank, Los Angeles, Calif., plans the construction of a fire brick plant at Manchester Ave. and Atlantic Blvd. Estimated cost \$250,000. Architect not selected.

**CANDY FACTORY**—T. O. Wright, Troup, Tex., is having plans prepared for the construction of a candy factory near intersections of highways from Troup, Tyler and Henderson, Tex. Private plans. All new machinery to be purchased.

**CANNING PLANT**—Canoga Citrus Fruit Assn., c/o J. I. Long, 1415 Manhattan Pl., Los Angeles, Calif., had plans prepared for the construction of a 1 story, 80 x 160 ft. canning plant on Roscoe St., Los Angeles, Calif. L. G. Knipe, 215 South Vermont St., Los Angeles, Calif., is architect.

**CANNING PLANT**—Julian Petroleum Corp., 448 South Hill St., Los Angeles, Calif., plans the construction of a canning plant at Mormon Island, San Pedro, Calif. Estimated cost \$50,000. Architect not selected.

**CANNING & PACKING PLANTS**—Texas Food Packers, D. B. Chapin, Pres., 505 National Bank Bldg., San Antonio, Tex., plans the construction of canning and packing plants for meat, poultry, vegetables, fruits, berries, etc., in various cities in Texas. Estimated cost \$3,000,000. Private plans. Owner is in the market for complete machinery and equipment.

**CEMENT PLANT**—Canada Cement Co., Ltd., Montreal, Que., plans the construction of a group of 10 buildings for plant at Lakefield, Ont. Estimated cost \$1,000,000.

**CEMENT PLANT**—Georgia Portland Cement Co., Augusta, Ga., awarded contract for the design and construction of a cement plant at Sandersville, Ga., to H. K. Ferguson Co., 4900 Euclid Ave., Cleveland, O. The first unit of 2 kiln with provision for third later will have a daily capacity of 3,000 bbl. Total estimated cost \$2,000,000.

**CEMENT PLANT ADDITION**—Alpha Portland Cement Co., Arcade Bldg., St. Louis, Mo., awarded contract for the construction of a 5 story, 70 x 150 ft. addition to cement plant including bag and packing house at Continental, Mo., to A. D. Gates Construction Co., Chemical Bldg., St. Louis, Mo. Estimated cost \$75,000.

**CEREAL FACTORY**—Canadian Kellogg Co., F. Gordon, Mgr., London, Ont., plans the construction of addition to factory. Estimated cost \$250,000. Equipment for the manufacture of corn flakes will be required.

**CHEMICAL ENGINEERING BUILDING** State Bd. of Education, W. H. Gemmill, Secy., State House, Des Moines, Ia., will receive bids until Feb. 24 for the construction of a 2 story chemical engineering building at Ames, Ia. Estimated cost \$45,000.

**CHEMICAL PLANT**—Allied Chemical & Dye Corp., 61 Broadway, New York, N. Y., has acquired a 300 acre site and plans the construction of a chemical plant for production of fixation nitrogen products at Hopewell, Va. Estimated cost \$5,000,000.

**CHEMICAL PLANT**—Tailby - Nason Co., 368 Congress St., Boston, Mass., manufacturers of chemicals, plans the construction of a factory at Amherst and Carlson Sts., Cambridge, Mass. Estimated cost \$50,000. Architect and engineer not selected.

**CHEMISTRY BUILDING**—Ohio State University, C. E. Steeb, Secy., Bd. of Trustees, Columbus, O., is having plans prepared for the construction of a 4 story, 60 x 160 ft. chemistry building on Campus. Estimated cost \$300,000. J. N. Bradford, c/o owner, is architect.

**CHEMISTRY BUILDING**—University of Wisconsin, J. D. Phillips, Bus. Mgr., Madison, Wis., will soon award contract for the construction of a 4 story chemistry building. Estimated cost \$150,000. A. Peabody, State Capitol, Madison, is architect.

**CLAY FACTORY**—Rutland Fire Clay Co., Rutland, Vt., awarded contract for the construction of a 3 story addition to factory on Curtis Ave. to A. J. Bissell, 52 Kingsley Ave., Rutland, Vt.

**CLAY PRODUCTS**—St. Marys Sewer Pipe Co., St. Marys, Pa., awarded contract for the construction of a 1 story, 300 x 300 ft. clay products plant to Hughes Foulkrod Co., Stevenson Foster Bldg., Pittsburgh, Pa. Estimated cost \$250,000.

**COKE BIN**—Providence Gas Co., 100 Weybosset St., Providence, R. I., will build a coke bin. Estimated cost \$500,000. Robbins Conveying Belt Co., 15 Park Row, New York, N. Y., is engineer. Work will be done by separate contracts under the owners supervision.

**COLOR & CHEMICAL WORKS**—Wabash Ry. Co., Exchange Bldg., St. Louis, Mo., plans to rebuild plant at 1009 South 9th St., Springfield, Ill., recently destroyed by fire. Estimated cost \$200,000. George B. Smith Color & Chemical Works, First National Bank Bldg., Springfield, Ill., is lessee, who will purchase machinery including two rotary furnaces, four pulverizers, two blenders, etc.

**COMPRESS PLANT**—Aransas Compress Co., Corpus Christi, Tex., will soon award contract for the construction of compress plants at Harlingen and Edinburg, Tex. Total estimate cost \$200,000. Private plans. Machinery will be required.

**COTTON COMPRESS PLANT**—Galveston Cotton Compress & Warehouse Co., W. L. Moody, Pres., 2028 Ave. D, Galveston, Tex., awarded contract for the construction of a 240 x 1100 ft. addition to cotton compress plant to M. C. Bowden, 1801 C St., Galveston, Tex. Estimated cost \$150,000. Owner is in the market for a high density compress and other machinery.

**COTTON OIL MILL**—San Antonio Oil Works, 411 North Cherry St., San Antonio, Tex., awarded contract for the construction of a 2 story, 42 x 130 ft. cotton oil mill to McKenzie Construction Co., Travis Bldg., San Antonio, Tex. Estimated cost \$38,640. Machinery will be required.

**DISTILLERY EQUIPMENT**—United Distilleries, Ltd., Marpole, B. C., is in the market for complete machinery and equipment for new plant.

**DRY CLEANING PLANT**—Market Dry Cleaning Co., c/o E. W. Goldstein, 814 Mutual Life Bldg., Buffalo, N. Y., Archt., is having preliminary plans prepared for the construction of a 2 story, 60 x 115 ft. dry cleaning plant on Niagara St. Estimated cost \$125,000.

**EARTHENWARE FACTORY**—Universal Sanitary Mfg. Co., New Castle, Pa., manufacturers of plumbers' sanitary earthenware, etc., had plans prepared for the construction of a 1 story plant near New Castle, Pa. Estimated cost \$50,000. The Austin Co., 16112 Euclid Ave., Cleveland, O., is architect.



**ENAMELED WIRE WORKS**—General Electric Co., C. G. Hulth, Supt. of Dept. of Buildings & Grounds, River Rd., Schenectady, N. Y., awarded contract for the construction of a 1 story, 180 x 280 ft. extension to enameled wire works to H. K. Ferguson Co., 4900 Euclid Ave., Cleveland, O. Estimated cost \$200,000.

**ENAMELED WIRE**—E. H. Phillips, Electrical Works Ltd., 12 Mercer St., Toronto plans the construction of additional buildings in connection with wire and cable factory including 1 story enameled wire building. Estimated cost \$150,000 to \$200,000. Engineer not selected.

**ENAMELING PLANT**—F. B. Ayers, c/o Louisville Industrial Foundation, Louisville, Ky., will soon award contract for the construction of a 2 story, 120 x 140 ft. enameling plant at 13th and Burnett Sts. Estimated cost \$100,000. Complete machinery and equipment for enameling stoves, scales, etc., will be required.

**GAS (ACETYLENE) PLANT**—Gas Products Co., J. M. Beatty, Pres., 100 North Skidmore St., Columbus, O., is having plans prepared for the construction of a plant for the manufacture of acetylene gas at Jennings Ave. and Howard Rd., Cleveland, O. Estimated cost \$200,000. Private plans.

**GAS PLANT**—City of Tallahassee, Fla., voted \$36,000 bonds for extensions and improvements to gas plant. B. H. Bridges, City Auditor.

**GAS PLANT, ETC.**—J. Courteau, 103 St. Francis Xavier St., Montreal, Que., Promoter, has applied for franchise for the construction of a gas plant and pipe distribution through city of Three Rivers, Que. Estimated cost \$1,000,000.

**GAS PLANT, ETC.**—Northern States Power Co., R. E. Pack, V.-Pres., 15 South 5th St., Minneapolis, Minn., plans an improvement program during 1927 including construction of a new gas plant at Faribault, Minn., etc. Private plans.

**GAS PLANT ADDITION**—Citizens Gas, Electric & Power Co., 56 Main St., Nantucket, Mass., is having plans prepared for the construction of a 2 story addition to gas and electric plant. Private plans.

**GAS PURIFICATION PLANT**—Malden & Melrose Gas Co., 200 Devonshire St., Boston, Mass., will have revised plans prepared for the construction of gas purification plant on Commercial St., Malden, Mass. Estimated cost \$40,000. C. H. Tenney Co., 200 Devonshire St., Boston, Mass., is engineer.

**GASOLINE PLANT**—Gypsy Oil Co., Frick Annex, Pittsburgh, Pa., plans to rebuild casinghead gasoline plant at Perry, Okla., recently destroyed by fire. Estimated cost \$100,000. Private plans. Complete new machinery and equipment will be required.

**GASOLINE PLANT**—Sinclair Oil Co., Sinclair Bldg., Tulsa, Okla., had preliminary plans prepared for the construction of a 1,900 bbl. casinghead gasoline plant at Seminole, Okla. Estimated cost \$75,000. Private plans. Four 250 bbl. casinghead gasoline compressors will be required.

**GLASS PLANT**—Illinois Pacific Glass Co., 1717 Industrial St., Los Angeles, Calif., is receiving bids for the construction of a 1 story, 80 x 320 ft. glass plant on Fruitland Ave. P. D. Burt, c/o Illinois-Pacific Glass Co., 15th and Folsom Sts., San Francisco, Calif., is engineer.

**GLASS PLANT**—Maryland Glass Corp., Mt. Winana, Md., will build a 2 story, 120 x 120 ft. glass plant at Linden and Ontario Sts., Baltimore, by day labor. Estimated cost \$40,000. Kubitz & Koenig, Emerson Tower, Baltimore, are engineers.

**GLASS PLANT**—Ohio Window Glass Co., I. Unger, Mgr., 4045 St. Clair Ave., Cleveland, O., will receive bids about Feb. 15 for the construction of a 2 story, 35 x 73 ft. glass plant. Estimated cost \$40,000. Private plans.

**GLASS PLANT ADDITION**—Mississippi Glass Co., 4070 North Main St., St. Louis, Mo., awarded contract for the construction of a 1 story, 78 x 100 ft. addition to glass plant, to Fruin-Colton Contracting Co., Merchants-Laclede Bldg., St. Louis, Mo. Estimated cost \$45,000.

**GRAPHITE, ROCK SALT, ETC.**—A. L. Flint, General Purchasing Officer of the Panama Canal, Washington, D. C., will receive bids until Feb. 19 for graphite, rock salt, ferrosilicon coke, carbonators, etc.

**LABORATORY**—South Western Engineering Co., 1221 Hollingsworth Bldg., awarded contract for the construction of a group of buildings for plant to include oil experimental laboratory and research department, 25 ton flotation plant, etc. Estimated cost to exceed \$600,000.

**LABORATORIES**—State Hospital Comm., State Capitol, Albany, N. Y., plans to install laboratories for special study and investigation in chemistry, pathology, bacteriology, etc., in the proposed new hospital and institute at 168th St. and Riverside Dr., for which contracts were recently awarded. Sullivan W. Jones, State Capitol, Albany, N. Y., is architect.

**LABORATORY, ETC.**—Catholic Bishop of Chicago, 740 Cass St., Evanston, Ill., awarded contract for the construction of a 3 story, 176 x 230 ft. high school including laboratories, etc., at Sherman Ave. and Austin St., to W. J. Lynch Co., 844 Rush St., Chicago, Ill. Estimated cost \$600,000.

**LABORATORY**—Charity Hospital, J. E. Crew, East 22nd St. and Central Ave., Cleveland, O., is having preliminary plans prepared for the construction of addition to hospital including laboratory, etc. Estimated cost \$1,200,000. George S. Rider Co., Century Bldg., Cleveland, O., is architect and engineer.

**LABORATORY**—Curtis & Tompkins, 331 California St., San Francisco, Calif., (industrial chemists) awarded contract for the construction of a 4 story laboratory to J. H. Hjul, 128 Russ St., San Francisco, Calif., engineer and contractor.

**LABORATORY**—Louisiana State Bd. of Health, New Court House Bldg., New Orleans, La., plans the construction of a 4 story, 32 x 120 ft. laboratory. Jones, Roessle & Olschner, Maison Blanche Bldg., New Orleans, La., are architects.

**LABORATORY (CHEMICAL)**—William S. Barnickel Co., 937 East Pacific St., Webster Groves, Mo., awarded contract for the construction of a 2 story, 55 x 83 and 65 x 99 ft. chemical laboratory on Pacific St., to W. H. Cunliff, 410 North Euclid Ave., St. Louis, Mo. Estimated cost \$80,000.

**LABORATORY (CHEMICAL), ETC.**—Cleveland Cap Screw Co., J. W. Fribley, Pres., 2921 East 79th St., Cleveland, O., plans the construction of a 3 story, 70 x 90 ft. heat treating and chemical laboratory. Estimated cost \$40,000. H. M. Morse, Finance Bldg., Cleveland, O., is architect and engineer.

**LABORATORY (CHEMICAL)**—Yale University, New Haven, Conn., is receiving bids for the construction of a chemical laboratory. Estimated cost \$150,000. H. C. Pelton, 415 Lexington Ave., New York, N. Y., is architect.

**LABORATORY (MEAT INSPECTION)**—City of Syracuse, N. Y., had plans prepared for the construction of a 1 story, 75 x 146 ft. meat inspection laboratory at Oswego Blvd. and Butternut St. A. Partridge, City Hall, is architect. N. F. Pitts, Jr., City Hall, is engineer.

**LABORATORY (PATHOLOGICAL)**—The University Hospitals Assn., F. A. Scott, Pres. of the Warner & Swasey Co., 5701 Carnegie Ave., Cleveland, O., is having plans prepared for the construction of a 4 story, 55 x 157 ft. pathological laboratory on Euclid Ave. Estimated cost \$750,000. A. Garfield, 915 National City Bldg., Cleveland, O., is architect.

**LINOLEUM PLANT**—J. F. Darling, Inc., 253 36th St., Brooklyn, N. Y., awarded contract for the construction of a 1 story, 230 x 525 ft. linoleum plant at Wilmington, Del., to Karno Smith Construction Co., Broad St. Bank Bldg., Trenton, N. J.

**MEDICAL PRODUCTS FACTORY**—Scott & Bowne, 54 Princess St., Toronto, Ont., plans the construction of a medical products factory on Fleet St. Estimated cost \$150,000 to \$200,000. Architect and engineer not selected.

**MILK (CONDENSED) PLANT**—Carnation Milk Products Co., S. McNeese, Local Mgr., Tupelo, Miss., will build a 2 story, 90 x 300 ft. condensed milk plant. Private plans.

**OIL MILL (COTTON SEED)**—Producers' Cotton Oil Co., c/o G. E. Neal, Hobart, Okla., is having plans prepared for the construction of a cold press cotton seed oil mill, 30 to 40 tons daily capacity. Estimated cost \$75,000. New machinery, probably electrically driven will be required. Private plans.

**OIL (NUT) MILL**—The Nut Oils of Washington, Inc., Seattle, Wash., plans the construction of a factory to convert waste products of Northwest peanut butter manufacturers into oil and cake, capacity 15,000 lb. oil and 20,000 lb. cake per mo.

**PACKING PLANT (CITRUS)**—Porterville Citrus Association, Porterville, Calif., is having plans prepared for the construction of a 1 story, 100 x 128 ft. packing plant on Porterville St. Estimated cost \$45,000. Hamm, Grant & Bruner, 607 Ferguson Bldg., Los Angeles, Calif., are architects and engineers.

**PAINT AND VARNISH FACTORY**—Gibson Homans Co., H. O. Gibson, Secy., and Treas., 2366 Woodhill Rd., Cleveland, O., manufacturers of paints, varnish and roofing cement, will soon award contract

for the construction of a 2 story, 50 x 56 ft. addition to factory. Estimated cost \$40,000. George S. Rider Co., Century Bldg., Cleveland O., is architect.

**PAPER PLANT**—Beveridge Paper Co., S. B. Sutphin, Pres., 717 West Washington St., Indianapolis, Ind., is having plans prepared for the construction of a 2 story paper manufacturing plant. Estimated cost \$45,000. Mothershead & Fitton, 542 North Meridian St., Indianapolis, Ind., are architects.

**PAPER (NEWSPRINT) MILL**—Abitibi Power & Paper Co., Iroquois Falls, Ont., will soon receive bids for the construction of a 200 ton newsprint mill at Cochrane, Ont.

**PAPER (NEWSPRINT) MILL**—Crown Willamette Paper Co., Pittock Bldg., Portland, Ore., plans the construction of a paper (newsprint) mill at Campbell River, B. C., initial capacity 200 ton daily, ultimate total capacity 1,000 ton daily. Estimated cost approximately \$15,000,000. Ultimate total cost \$50,000,000. Agreement has been made with the B. C. Government for hydro-electric development of Campbell River Falls. B. C. Condit, 365 Bellevue St., Oakland, Calif., is engineer.

**PHOSPHATE PLANT**—International Agricultural Corp., Wales, Tenn., awarded contract for the construction of a phosphate plant to Huggar Bros. Construction Co., Sheppard Bldg., Montgomery, Ala. Estimated cost \$150,000.

**PICKLE FACTORY**—Wildar Mfg. Co., Cleveland, O., will soon award contract for the construction of a 2 story, 60 x 680 ft. pickle and other food products factory at Hattiesburg, Miss. Estimated cost \$100,000. B. C. Hearon & Son, Hattiesburg, Miss., are architects.

**POTTERY PLANT**—Homer Laughlin China Co., Newell, W. Va., plans the construction of a pottery plant unit. Estimated cost \$200,000. Tunnel kilns and clay working machinery will be required.

**PREST-O-LITE FACTORY**—Prest-O-Lite Co., Inc., Schmidt Bldg., Cincinnati, O., awarded contract for the construction of a 2 story, factory on Brotherton St., to Blaw-Knox Construction Co., Farmers Bldg., Pittsburgh, Pa. Estimated cost \$60,000.

**PRESERVING, CANNING AND DEHYDRATING PLANTS**—Winter Garden Securities Co., W. B. Bass, Secy. and Treas., Republic Bank Bldg., Dallas, Tex., is having plans prepared for the construction of preserving, canning and dehydrating plants in connection with new development of Seefeld Switch between Carrizo Springs and Bldg Wells, Tex. Total estimated cost \$150,000. Private plans. Machinery will be required.

**PULP & PAPER MILL**—The Grays Harbor Pulp Co., Gray Harbor, Wash., incorporated for \$2,900,000 by J. C. Shaw and J. C. Hogan, representing the Zellerbach Pulp & Paper Co., plans the construction of a pulp and paper mill 100 ton wood pulp daily capacity. Estimated cost \$3,000,000.

**PULP & PAPER MILL**—Thunder Bay Pulp & Paper Co., Port Arthur, Ont., has work under way on the construction of a pulp and paper mill, 400 ton daily capacity. Owner is in the market for equipment.

**REFINERY**—Munger Oil & Cotton Co., Mexia, Tex., has acquired the plant of the Mutual Refining Co. at Sherman, Tex., and will rehabilitate. Oil will be shipped from other plants to be refined. Private plans. Machinery will be required.

**REFINERY (SUGAR)**—Chamber of Commerce, Seattle, Wash., had approved a plan to form a corporation for building and operating a sugar refinery. Initial plant will have a daily capacity of 250 tons. Estimated cost \$2,000,000.

**ROOFING PLANT**—Certain-Teed Products Co., 100 East 42nd St., New York, N. Y., awarded contract for the construction of a 1 story, 125 x 238 ft. addition to roofing plant at Marseilles, Ill., to Wimmer Contracting Co., 916 Victoria Bldg., St. Louis, Mo. Estimated cost \$60,000, also plans a 2 story, 109 x 145 ft. addition to roofing plant at York, Pa. Klipstein & Rathman, 316 North 8th St., St. Louis, Mo., are architects.

**RUBBER PLANT**—H. S. Cover, South Michigan Rd., South Bend, Ind., awarded contract for the construction of a 1 story, 60 x 130 ft. plant to H. G. Christman, 306 South Notre Dame St., South Bend, Ind. Estimated cost \$50,000.

**TIRE & RUBBER FACTORY**—Goodyear Tire & Rubber Co., East Market St., Akron, O., awarded contract for the construction of a 5 story, 101 x 201 ft. factory at Central Ave. and 67th St., Los Angeles, Calif., to W. D. Lee, 709 Textile Center Bldg., Los Angeles, Calif. Estimated cost \$127,738.